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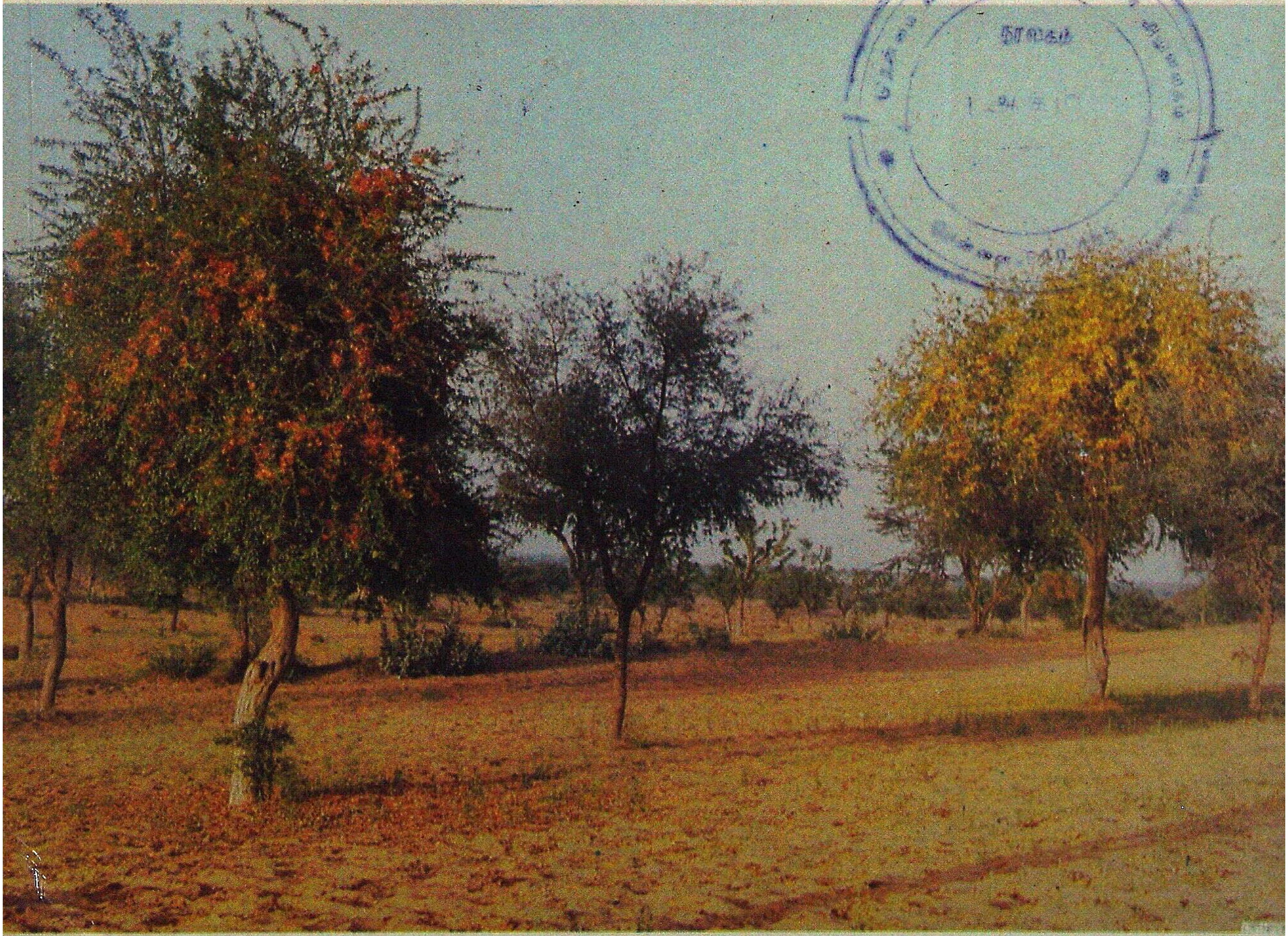

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FRONT COVER

A NATURAL STAND OF *TECOMELLA UNDULATA* (ROHERU, RAJASTHAN TEAK) ON A STABILISED SAND DUNE IN BHIWANI DISTT. (HARYANA).

Photo - S.S. Jattan

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* *

ROLE FOR INDUSTRY IN THE DEVELOPMENT OF DEGRADED FORESTS : A NEED FOR CHANGE IN POLICY

J.K. RAWAT*

Forest Research Institute, Dehra Dun (India)

Introduction

Degraded forests constitute nearly one fourth area of the total wastelands identified in the country. Several agencies such as Forest Departments, panchayats or village societies, voluntary groups and non-government organisation have been involved in the development of wastelands. One agency that has been kept out deliberately in this activity is "Industry". National Forest Policy of 1988 specifically lays down that forest based industries should raise the raw material outside the forest area by establishing a direct relationship between the factory and the individuals who can grow the raw material. The National Forest Policy thus gives a very casual or step-motherly treatment to forest based industries.

The forest based industries consist of pulp and paper, news print, plywood, match, rayon, panel products and charcoal manufacturing firms. These make a sizable contribution to our domestic economy as well as to the exports. The above mentioned industries can play a much greater role in the national economy but their several units are working below their respective installed capacities. This is largely due to inadequate or uncertain supply of raw material i.e., wood. The most practical way to overcome this problem and to strengthen these industries is by giving them long term lease over degraded forest lands for raising plantations so as to meet their requirement of raw material. This will necessitate a change in the existing forest policy.

The most compelling reason for suggesting change in forest policy is that the industry has resources that can be utilized for wasteland development. The technology for afforestation and reclamation of degraded forests is costly and requires heavy investment. The government does not have adequate resources to develop these wastelands at the desired speed. Thus resources available with the industry can be harnessed for this purpose. Government will get rent or royalty for the area leased out to the industry and the latter, in return, will get an assured supply of raw material.

Discussion

What has been proposed above is not new. Therefore, it is important to analyse why such a step has not been taken so far. The industry has been kept out of forest land because of certain objections and problems that are anticipated to arise. Before contemplating any change in policy, it is necessary to examine, with an open mind, these objections and fears and to suggest

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how can the interests of society and the nation be safeguarded. These are discussed in the following paragraphs.

1. *The fulfilling of basic needs for fuel and fodder of the local population will be adversely affected !*

The industry will be allowed to exercise rights over the forest lands under well thought out terms and conditions. The terms would be laid out in such a way that access of local people into the forest for grasses and other minor forest products is not restricted. Though grazing would not be permitted, the need of people for firewood would, however, be met from the forest produce grown in the leased area. This will be done by inducing high productivity in that area since forest soils are quite fertile but need proper management. The productivity of degraded forest if left to natural regeneration, is very low viz. about 1-2 m^3 per ha per year. Average annual productivity for the country as a whole is about 0.7 m^3/ha. However, with improved afforestation techniques, additional inputs of fertilizers and irrigation, and intensive management, productivity within 10-20 m^3 per ha per year can be achieved. It has been recorded that over 20 per cent volume of a natural tree consists of lops and tops which can be preserved for the use of local people as firewood. This amounts to an annual availability of 2-4 m^3 per ha which is far more than the produce available from the undeveloped forest land. A committee consisting of representatives from Forest Department, industry and local people can be formed to oversee the distribution of forest produce.

2. *Rights on forest land will further enhance economic and political power of the industry !*

Economic and political power is derived from the extent of asset and manpower controlled. Employing labour for afforestation work and owning an inventory of tree wealth will certainly increase power of industry to a certain extent. This is what is meant by strengthening of an industry so that it is on a surer footing than before. However, to presume that this will be to the detriment of the society may not be correct. Moreover, certain safeguards will be kept to protect the interests of the society and the country. For instance, industry will be given right only to produce grown by them but will have no right to land. It will raise only those trees which supply raw material for its factories. The land will be subject to Forest Conservation Act of 1980 whereby land can not be diverted for non-forestry purposes. Hence, there is no fear of industry using the land for speculative purpose or for gaining any political mileage out of it. Moreover, only the degraded and open forest lands will be leased to the industry. The right of an industry over forest land will be subject to several terms and conditions controlled by the State Forest Departments. The industry will have to submit annual and long term management plans which will be scrutinised and approved by the Forest Department before any harvesting is permitted in the area. In order to safeguard interest of the tree growers and private suppliers, it is suggested that industry be leased an area adequate for producing not more than 50 per cent of its raw material needs.

3. *Industry will exploit land by mining resources on unscientific basis and raise monoculture plantations creating adverse ecological impact !*

Mining of resources will take place only if lease period is short, or the

extension of lease is uncertain and the industry has to recover its investment in a short period. In order to ensure that the industry uses the land on sustainable basis and not as a mine of wood raw material, the period of lease should be long enough to cover at least 2-3 rotations of plantation crop. In case of fast growing species this should be anywhere between 15-20 years. The lease should be on an extendable basis and there should be a provision to give extension for, say 5 years after the expiry of every 5 year period, subject to satisfactory compliance of terms of lease by the industry. This will help industry in having a long term perspective as far as their raw material needs are concerned. In addition, industry can invest in research and development and in improving the forest productivity further if the rent or royalty is charged on per ha basis rather than on output basis. This will give an incentive to the industry to increase productivity by applying tree improvement and advanced afforestation technology. The rate of royalty should, however, be linked with the price index of the finished goods manufactured by the industry. Regarding question of scientific management of plantations, it is noted that forestry is being taught in several universities now and there should be no dearth of trained personnel who can be employed by the industry to manage these plantations.

Demand of industries such as paper and pulp, rayon, match, fiber board, charcoal, etc. using small sized trees is of the order of 20 million m^3 per year. If 50 per cent of this volume is to be grown from captive plantations, with an induced productivity of say 10 m^3/ha/year, a total area of just 1 million ha will be needed. It is only a small fraction of the country's forest land and monoculture over it is not likely to have any adverse ecological impact.

4. *Industry will control the price of wood to the detriment of private suppliers!*

Wood is a bulky product and is difficult to transport to far off places. Therefore, by its very nature it is difficult to have a competitive market for industrial wood. Hence, it is inevitable that a wood based industry, whether having lease over forest land or not, will have a say in deciding price of raw material. The wood market will either be a monopsony market where a large number of private wood growers supply to a single industrial unit, or it will be a case of bilateral monopoly where an industrial unit faces a single supplier such as Forest Department. In the first case the price is decided by the industry while in the second case it is negotiated between the buyer and the supplier. Since it has been suggested that extent of forest area leased to the industry should be adequate only to produce upto 50 per cent of its wood requirement, the industry will have to depend on private suppliers for the other half. Whether private suppliers, mostly tree growing farmers, are exploited or not exploited by the industry depends upon the tree growers themselves. If they take initiative and form tree growers cooperatives, they will be in a stronger positions to negotiate wood price and other terms of supply with the industry.

Conclusions

From the discussion above we can see that there are no logical grounds for prohibiting involvement of industry in afforestation activities on degraded forest lands. The objections and problems generally put forward are not insurmountable. We have to overcome our prejudice against industry first and examine each case on its merit and, through terms of contract, safeguard the interest of the nation.

At present, in several states, the industry is procuring forest produce from the government forests on payment of royalty. The rates of royalty are generally low and thus, in other words, we are subsidising the supply of wood to the industry. Why should the State Forest Department grow wood for industry when the latter has means and know how to grow its own raw material. Instead, we only have to allow them long term lease for afforestation over otherwise unproductive degraded forest lands. Although, implementation of this policy will not be easy and will need a thorough discussion before acceptance, it is necessary to at least not to have a closed mind towards such a move.

The forest based industries play an important role in the economic development of the country. It is important to modify forest policy so as to involve them in the development of degraded forest lands and thereby helping the industry as well as the nation.

SUMMARY

National Forest Policy of 1988 prohibits raising of captive plantations by industry on forest lands. A change in this policy is recommended. The forest based industries have resources which can be harnessed to develop degraded forests by giving them long term lease over these areas where they can grow wood for their factories. Problems and objections likely to arise due to the proposed shift in policy and the ways to safeguard interests of the society and the nation have been discussed.

व्याहसित वनों के विकास में उद्योगों की भूमिका-नीति बदलने की आवश्यकता

जे0 के0 रावत

सारांश

1988 की राष्ट्रीय वन भूमि पर अपने रोपवन लगाने पर प्रतिबन्ध है । इस नीति को बदलने की सिफारिश की गई है। वनाधारित उद्योगों के पास इतने संसाधन हैं कि उन्हें व्याहसित वनों का विकास करने के लिए इन क्षेत्रों को लम्बे पट्टे पर देकर, जिन पर वे अपनी निर्माणियों के लिए लकडी उगा सकते हैं, इन्हें उपयोग में लाया जा सकता है। नीति में प्रस्तावित बदलाव लाने से जो समस्याएँ या आपत्तियाँ उठेंगी उन्हें तथा समाज और राष्ट्र के हितों को सुरक्षित करने का विवेचन किया गया है।

PRELIMINARY OBSERVATION ON CONTROL OF SLUMPING THROUGH MANGROVE AFFORESTATION AT NAYACHARA, WEST BENGAL (INDIA) - A CASE STUDY

P.K. ROY CHOUDHURI*

Introduction

Nayachara Island is a new accretion area formed in the estuarine reaches of the river Hooghly opposite to Haldia Port as a result of silting during the last six decades or so. It is situated in the Midnapore District of West Bengal within the latitude 22°-00'-30" N and the longitude 80°-07'-47" E and the sea is 50-52 (90-94 km approx.) nautical mile away from the Nayachara towards south. The total area is 29.38 km^2. This place is subjected to intensive river training activities. The Island has also assumed important as it plays a significant role in regard to the navigability of the river Hooghly in the estuarine reaches. The area is situated far away from the natural mangrove habitats. No previous attempts of protective afforestation through mangrove plantation in such areas have been reported.

Objectives

1. To study the effect of mangrove plantation on the protection against slumping of shore lines and arresting of silt load.

2. Comprehensive measure for improvement of draught.

3. Eco-development of the barren uninhabited area through vegetative cover.

Physical Constraints : The climate in this region is sub-tropical. The mean annual rainfall is 2500 mm concentrated mostly from mid May to mid October. The area is subjected to high wind throughout the year. High tides and low tides occur daily with an average flooding period of 5 hours and ebbing period of 7 hours. The bank material is fine Sand - 0.30%, Silt - 61.70%, Clay - 38%.

Biotic Constraints : No human habitation exists in the Island. The villagers of neighbouring areas use this Island as a pasture ground for grazing. This poses threat not only to river training structure but also to mangrove plantation.

Materials and Methods

The author frequently visited from 1990 to 1992 Nayachara Island and its periphery and studied various aspects of silviculture and ecology of mangrove species as well as geohydrological changes in the Hooghly river.

Soft mud-flat subjected to regular inundation along the periphery have been found to be suitable for mangrove plantation (Banerjee and Roy Choudhuri, 1986). So far about one million numbers of Mangrove seedlings and propagules transplanted over 200 hectares of blank

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foreshore areas along the river Hooghly during 1990 and 1991 by collecting and carrying pre-germinated seeds, propagules from Sundarban Tiger Reserve and also by transplanting nursery raised seedlings at Nayachara. Soil preparation is done by digging up pits and making ridge by cutting longitudinal trench and refilling by natural process.

The problem of siltation is very severe in this region during October to March. Such phenomenon is also not uncommon in Sundarban but the severity is much higher here. In many cases the rate of silt deposition exceeds the growth of seedlings. As a result the seedlings get buried under the silt and thus the survival percentage is low. Although desiltation programme is taken up during maintenance operation, it is not only very expensive but the results are also not entirely satisfactory.

During the period from March to September, the intensity of wind and wave induced arosion is very severe particularly on the western and eastern parts of the Island. This results in washing away of the seedlings, perhaps repeated transplanting with sturdier seedlings with well developed root system (in bigger polytube with creek mud). Table 1 reveals the shoaling and scouring intensity during various periods of the year.

Results and Discussion

1. The seedlings transplanted on Western Bank suffered badly due to slumping (bank erosion) and the seedlings get buried under silt.

2. The problem of siltation is very severe in the western and part of the eastern bank during October to March. Such pheno-

Table 1

Geomorphological changes on Western Bank at Nayachara

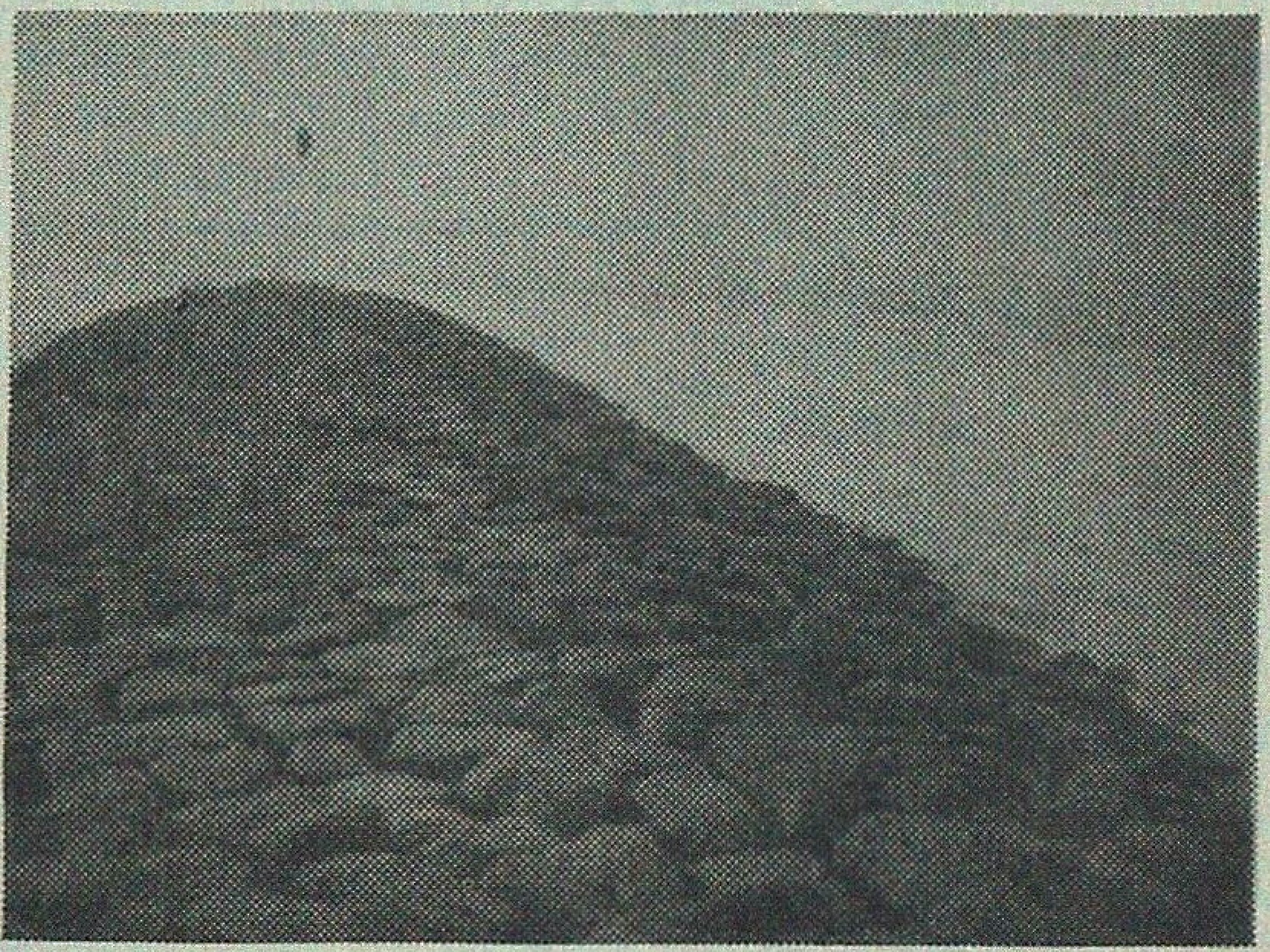
Period	In between cross spur and spur-2	In between spur-2 and spur-4	In between spur-4 and spur-5	In between spur-5 and spur-6	In between spur-6 and spur-8	In between spur-8 and spur-10 Revetment provided
July, 1990	-3.0	+2.0	+1.9	-0.6	-3.7	-6.5
March, 1991	-2.9	+2.4	+2.1	+1.0	-2.8	-6.6
Difference	+0.1	+0.4	+0.2	+1.6	+0.9	-0.1
March, 1991	-2.9	+2.4	+2.1	+1.0	-2.8	-6.6
Sept., 1991	-2.1	+2.8	+1.1	+2.0	-4.7	-7.1
Difference	+0.8	+0.4	-1.0	+1.0	-1.9	-0.5

Note: 1. All readings are in metres.
2. Location has been taken 20 m from Survey base line which is the planting site.
3. (+) = Shoaling and (-) Scouring.
(Source : Special R.T. Cell).

Plate 1

2½ year old *Sonneratia apetala* plantation and other mangrove species at Mangrove Interpretation Centre, Nayachara.

Plate 2

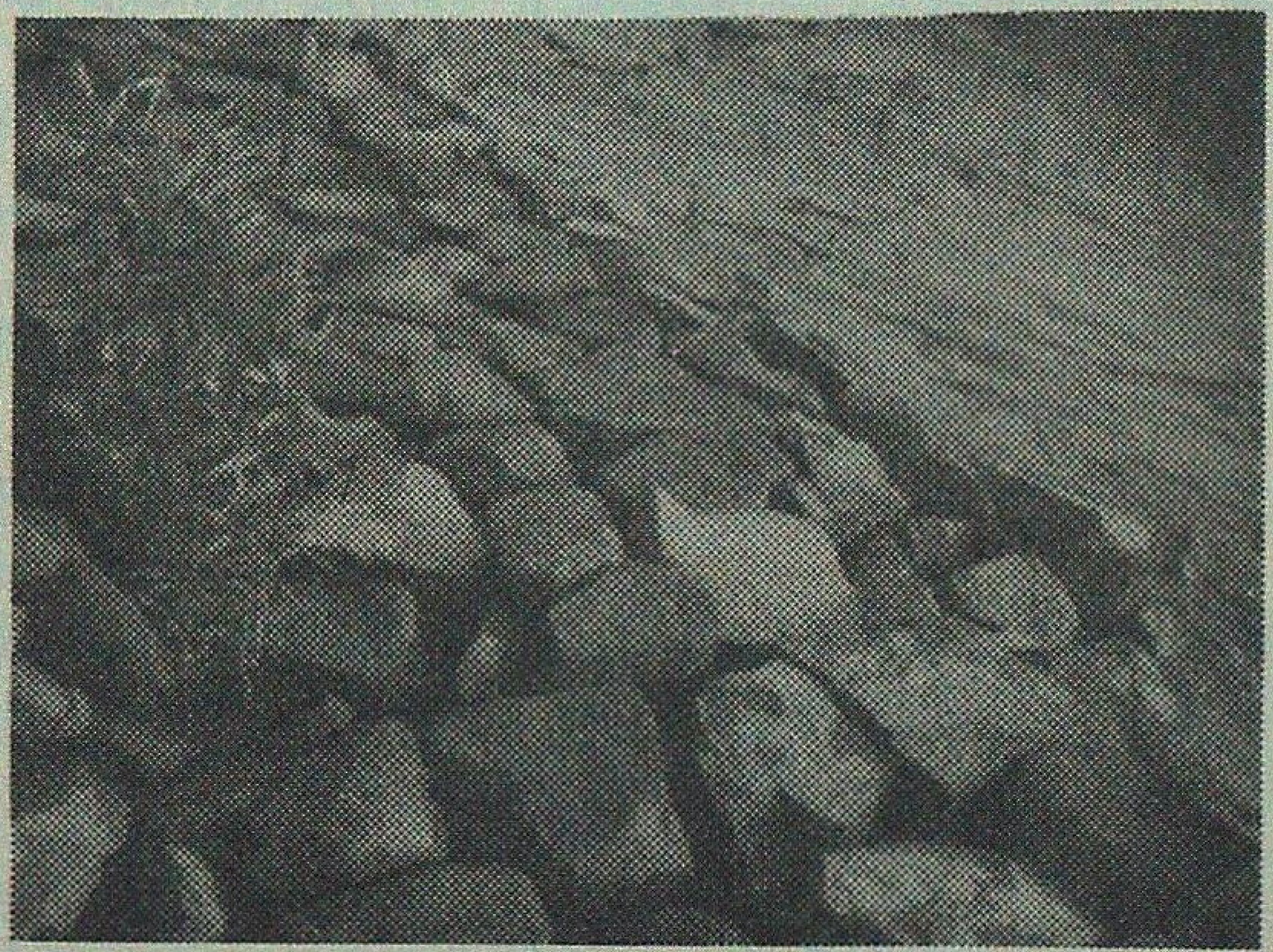


2½ year old *Avicennia* spp. in the interspaces of lateritic boulders at cross-spur, Nayachara.

Plate 3

Close-up view.

Plate 4



Avicennia spp. with pneumatophores.

menon is also not uncommon in Sundarban but the severity is much higher here.

3. During the period from March to September, the intensity of wind and wave induced erosion is very severe particularly on the western and eastern sides of the Island. This results in washing away of seedlings.

4. The salinity of water is varying between 0.31 mm hos to 9.8 mm hos (Table 2) and there is every reason of slow growth due to such adverse salinity conditions. This wide variation in salinity appears to be the main reasons for poor survival of species like *Bruguiera gymnorhiza* (L) Lam., *Aegiceras corniculatum* (L) Blanco., *Ceriops* spp, *Nipa fruticans,* Wurmb.

Table 2
Water Salinity at Nayachara

Period	Month/ Year	P.H. Value	Ece/in mm hos at 25°C
Prefreshet	March '91	7.9	4.30
	April '91	7.6	4.30
	May '91	7.5	4.45
Freshet	June '91	7.9	3.60
	July '91	7.5	1.22
	August '91	7.5	0.31
	Sept. '91	7.7	0.39
	Oct. '91	7.15	4.7
	Nov. '91	7.0	5.76
Post Freshet	Dec. '91	7.3	8.7
	Jan. '92	7.4	9.8
	Feb '92	7.5	9.8

Water samples analysed by : Central Soil Salinity Research Station, Canning South - 24 Parganas.

5. *Sonneratia apetala* (Buch-Ham) is growing well (Roy Choudhuri, 1990) and number of pneumatophores are noticed in two years old plantation. These are obstructing the direction of the current and help in quicker deposition of silt and binding the soil with their tangle mass of roots.

6. *Sonneratia apetala* stands are developing gradually into the habitats for avifauna like *Swallow swift, Heron, Drongo, Tufted poachard* and *Black headed gull.*

7. No specific improvement of draught can be ascertained at this stage. Only a good amount of siltation is noticed on the eastern bank. That may not co-relate with the improvement of draught on the western side of river Hooghly. It needs further study on river hydrology and sediment transport behavior particularly on western side of Nayachara Island.

Conclusion

1. Artificial regeneration of mangrove species for away from the natural forest areas are possible and probability of further extension appears to be high (Table 3).

Table 3
Height Growth

Species	One year old Average height (m)		Two years old Average height (m)	
	Sundarban	Nayachara	Sundarban	Nayachara
Avicennia spp.	0.39	0.46	2.60	0.91
Bruguiera gymnorhiza	0.59	0.34	0.88	0.50
Sonneratia apetala	0.97	0.60	1.28	1.95
Ceriops spp.	0.28	0.15	0.43	0.26
Rhizophora spp.	0.80	0.27	1.25	0.81
Xylocarpus granatum	0.90	0.64	1.14	0.76
Xylocarpus mekongensis	0.64	0.73	1.14	0.77
Nipa fruticans	0.80	0.63	1.04	0.90

The height growth of plantation were recorded and presented in Table 3 along with Sundarban Mangrove Plantation.

2. *Sonneratia apetala* with *Avicennia* species are showing promise along with associated species viz. *Bruguiera gymnorhiza* (L) Lam. and *Rhizophora* spp.

3. No definite view regarding effectiveness of mangrove plantation in control of slumping could yet be formed. Although on the Northern and Eastern part, they appear to be quite effective.

4. Use of longer and stouter seedlings 1-2 years old with well developed bushy

root system grown in bigger polypots in nursery along with geo-jute covered with laterite boulders ensure better performance. Such attempts will be made during the current planting season. The results will be monitored to form a clearer recommendation as regards plantation technique.

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SUMMARY

This paper deals with the prospect of raising mangrove plantation at Nayachara in the Midnapore District far away from the mangrove habitat. The plantation were initiated during the year 1990 and covered foreshore areas of Nayachara along the river Hooghly. *Sonneratia apetala*, with *Avicennia* Spp. should be the principal species with minimal percentage of *Bruguiera gymnorhiza* (L) Lam and *Rhizophora* Spp. Tansplanting of longer and stouter nursery raised mangrove seedling in polypack in the interspaces of laterite boulders over geo-jute covering should ensure better performance in vulnerable areas. Such attempts have never been made earlier and there is very little information about artificial regeneration of mangrove species in these areas.

नयाचाड़, पशिचम बंगाल (भारत) में वायुशिफ रोपवनों में आए मन्दन का नियन्त्रण करने पर प्रारम्भिक पर्यवेक्षण - एक विशेष अध्ययन

पी0 के0 राय चौधरी

सारांश

इस अभिपत्र में वायुशिफ प्राकृतावास से काफी दूर मिदनापुर जिले के नयाचाड़ में वायुशिफ रोपवन लगाने की संभावनाओं का विवेचन किया गया है। ये रोपवन वर्ष 1990 में शुरु कराए गए और इसे हुगली नदी के किनारे-किनारे नयाचाड़ के अग्रतट पर लगाया गया । *सोनेरेशिया एपिटाला* के साथ *एवीसेनियस* की जातियां मुख्य और उनके साथ *ब्रूगेरिया जिम्नोराइजा* (लि0) लम और *राइजोफोरा* जातियों का न्यूनतम प्रतिशत रखकर पोलिथीन थैलियों में मिट्टी पटसन की परत के ऊपर पर इष्टिकिजीय पत्थरों के बीच खाली जगहों में, ताकि क्षति हो सकने वाले क्षेत्रों में उनकी क्रियाशीलता अच्छी रह सके, रोपणियों में उगाए वायुशिफों के लम्बे और मजबूत पौधे प्रतिरोपित किए गए। ऐसा प्रयास पहले कभी नहीं किया तथा इन क्षेत्रों में वायुशिफ जातियों का कृत्रिम पुनर्जनन कराने के विषय में बहुत कम जानकारी मिलती है।

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REHABILITATION OF OPEN-CAST COAL MINES IN SINGRAULI REGION OF UTTAR PRADESH AND MADHYA PRADESH

SHYAM LAL*

Introduction

Singrauli Coalfield belt is situated in District Sonbhadra (U.P) and Sidhi (Madhya Pradesh). The terrain is hilly and undulating and lies in Vindhyan Hill ranges between 24° to 24°46 N Latitude and 82° 5" to 82° 40" E Longitudes. Most of the area belongs to Forest Departments. The Coalfield is spread over an area of 2200 km^2. Only 80 km^2 lies in Sonbhadra District and rest is in Sidhi District.

The tract is covered with dry deciduous forests having moderate to good density, bears heavy pressure of grazing and firewood of local people. The forest cover consists of *Acacia catechu, Dendrocalamus strictus, Diospyros exsculpta, Lagerstroemia parviflora, Holarrhena antidysenterica, Boswellia serrata, Balenamia lensin* and *Madhuca latifolia.* Northern protected valleys bear pole size *Shorea robusta* crop.

The climate is dry tropical with temperature reaching upto 48°C during June and lowering down to 5°C in January. Rainfall varies from 900 to 1000 mm confined during monsoon months from June to September. Winter rains are negligible.

Geological formation is susceptible to erosion overlying sand stone with coal seams of various depth varies from 8 m to 135 m thickness. Geologically it belongs to lower Gondwona series with rock formation of Damunda type of Baraka series.

The Study Area

Singrauli coalfield covers 11 coal mines. The locations and their capacity are given in Table 1 and Fig. 1.

Overlying sandstone of coal seams has coarse grains, which forms the main constituent of the over-burdens created after removal of coal from the open-cast mines. The extent of air pollution can be observed by observing white cloth lying outside becoming black in the morning.

The loose fragile and inert O.B. needs to be stabilized as early as possible through afforestation.

The O.B. are unstable and susceptible to heavy erosion even with little rain. The flow of debris causes disturbance in coal production. This needs immediate reclamation. Afforestation is the cheapest method of reclamation of internal and external dumps having height of 30-100 m.

Materials and Methods

When the author was Divisional Forest Officer, Renukoot, he contacted all the General Managers and appraised them of the offer of Forest Department to take up planting of O.B. at the cost of projects at departmental rates and assured more than

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Table 1

Coal mine	Location	Ultimate capacity (mt)	Sanctioned capacity (mt)	Consumers
Gorbi	M.P.	1.50	1.50	Obra Power Station
Jhingurdah	M.P.	3.00	3.00	Renusagar Power Station
Kakri	U.P.	2.50	2.50	Anpara Power Station
Bina	U.P.	4.50	4.50	Obra Power Station
Dudhichuwa	U.P./M.P.	10.00	5.00	Shaktinagar Power Station
Khadia	U.P./M.P.	10.00	4.00	Production not yet started.
Jayant	M.P.	10.00	10.00	Shaktinagar Power Station.
Amlohri	M.P.	10.00	4.00	Rihand Bijpur Station.
Nighai	M.P	10.00	4.00	Vindhyachal Power Station.
Morrak	U.P.	-	-	Yet not planned.
Maher	M.P.	-	-	Under planning.

80% success after 3 years, though planting of the areas were being done by them through contractors without any success. First plantation of 10,000 plants was done during 1983 in Jayant Coal Mine by U.P. Forest Department. This effort of F.D. created impact of afforestation for the area. Form 1984 most of the projects came forward to get their areas afforested through F.D.

The huge quantity of O.B. created is 2-3 times as compared with coal production. The information of Bina Coal Mine in Table 2 reveals the same.

Choice of species was done considering the inert infertile, absence of microbes and reverted C.M.P. ratio of O.B. Leguminous species capable of N_2 fixation, increasing soil biological activities and accelerating natural vegetation of the area was the main basis for selection of species. The species planted were: *Acacia auriculiformis, Cassia siamea, Albizia lebbek, Prospopis juliflora, Dalbergia sissoo, Acacia catechu, Inga dulce, Delonix regia, Peltoforum ferruginatum, Cassia fistula, Parkinsonia, Acacia nilotica, Eucalyptus, Casuarina equisetifolia, Tecoma, Phyllanthus emblica, Azadirachta indica, Terminalia arjuna, Eugenia jambolana, Anthocephalus kadamba, Madhuca latifolia, Tamarindus indica, Ficus* spp., *Bougainvellia.*

Table 2

Year	Coal production (M.T.)	O.B. Production (m^3)
1976-77	48,000	20,01,000
1977-78	1,50,515	16,53,000
1978-79	6,98,655	17,01,000
1979-80	12,00,680	23,24,000
1980-81	17,50,414	28,01,875
1981-82	20,45,685	33,44,218
1982-83	23,72,000	28,99,843
1983-84	25,50,000	34,70,000
1984-85	26,93,000	35,80,000
1985-86	31,00,000	36,76,000
1986-87	39,60,000	60,10,000
1987-88	45,03,000	96,75,000
1988-89	45,28,000	1,05,98,400
1989-90	46,12,000	1,13,47,000
1990-91 (Upto Oct. '90)	24,92,000	65,72,000

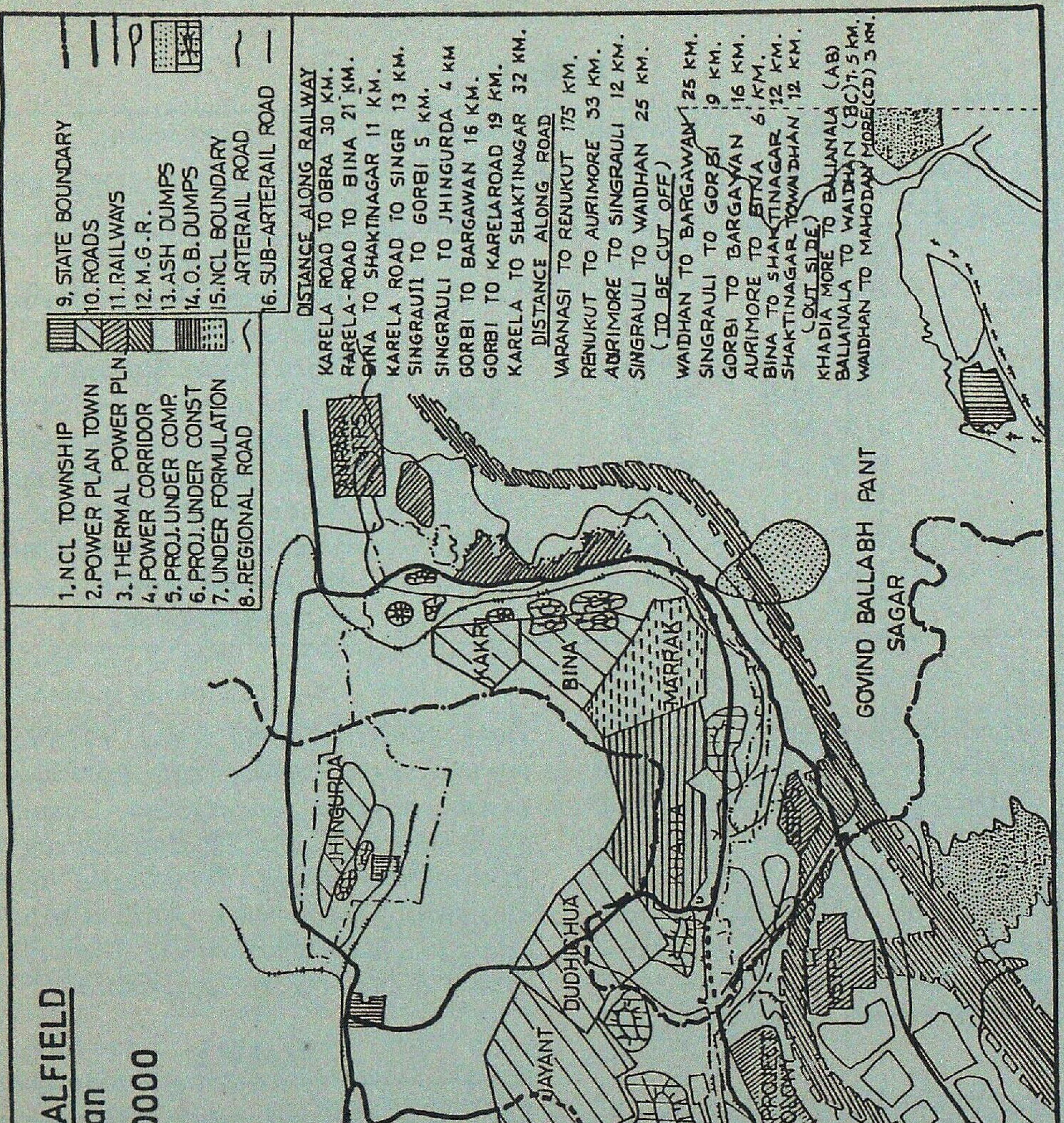

SINGRAULI COALFIELD
Master Plan
Scale- 1:80000
1.NCL TOWNSHIP
2.POWER PLAN TOWN
3.THERMAL POWER PLN
4.POWER CORRIDOR
5.PROJ.UNDER COMP
6.PROJ.UNDER CONST
7.UNDER FORMULATION
8.REGIONAL ROAD
9. STATE BOUNDARY
10.ROADS
11.RAILWAYS
12.M.G.R.
13.ASH DUMPS
14.O.B.DUMPS
15.NCL BOUNDARY ARTERAIL ROAD
16.SUB-ARTERAIL ROAD
DISTANCE ALONG RAILWAY
KARELA ROAD TO OBRA 30 KM.
KARELA-ROAD TO BINA 21 KM.
BINA TO SHAKTINAGAR 11 KM.
KARELA ROAD TO SINGR 13 KM.
SINGRAULI TO GORBI 5 KM.
SINGRAULI TO JHINGURDA 4 KM
GORBI TO BARGAWAN 16 KM.
GORBI TO KARELAROAD 19 KM.
KARELA TO SHAKTINAGAR 32 KM.
DISTANCE ALONG ROAD
VARANASI TO RENUKUT 175 KM.
RENUKUT TO AURIMORE 33 KM.
AURIMORE TO SINGRAULI 12 KM.
SINGRAULI TO WAIDHAN 25 KM.
(TO BE CUT OFF)
WAIDHAN TO BARGAWAN 25 KM.
SINGRAULI TO GORBI 9 KM.
GORBI TO BARGAWAN 16 KM.
AURIMORE TO BINA 6 KM.
BINA TO SHAKTINAGAR 12 KM.
SHAKTINAGAR TO WAIDHAN 12 KM.
(OUT SIDE)
KHADIA MORE TO BALIANALA (AB)
BALIANALA TO WAIDHAN (BC) 7.5 KM.
WAIDHAN TO MAHODAN MORE (CD) 3 KM.
GORBI
MOHER
AMLORI
NIGAHI
JAYANT
DUDHICHUA
KHADIA
JHINGURDA
BINA
KAKRI
MARRAK
PROJECT COLONY
GOVIND BALLABH PANT SAGAR

Table 3

Name of coal mines.	Number of plants planted							
	Upto 86-87	87-88	88-89	89-90	90-91	91-92	Total	Area (ha)
1	2	3	4	5	6	7	8	9
Singrauli	14500	25000	40000	25600	4380	-	109480	42
Jhingurdah	14550	60540	100000	50300	102400	130000	457790	90
Amlohri	29200	165420	49000	50000	101300	100000	493920	117
Nigahi	500	30000	84050	87000	107500	70000	379050	80
Jayant	76690	56230	98430	220675	280854	450000	1182879	181
Gorbi	5600	40000	33640	87000	53110	73000	297350	66
Dudhichuwa	10000	28440	60000	71000	80600	150000	400040	68
Bina	67040	18500	226000	227000	250000	250000	1038540	262
Kakri	30120	35000	50000	75000	70000	120000	411120	76
Khadia	-	130000	70000	41000	40000	65000	346000	96

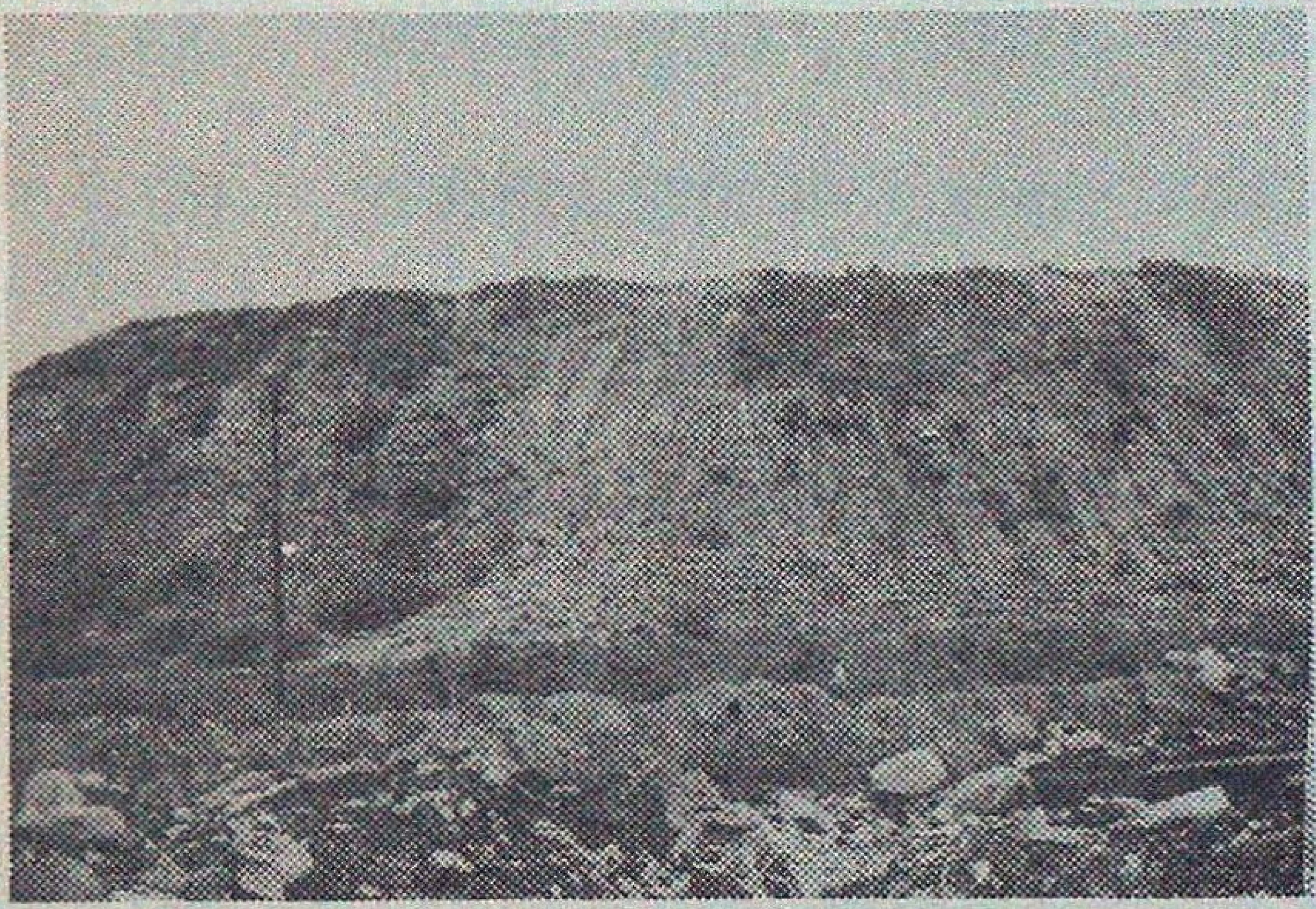
Table 4

Terminal year	Actual				Projected	
	84-85	86-87	88-89	89-90	94-95	1994-2000
Coal production M.T.	10.72	13.57	19.60	23.00	42.15	51.90
O.B. Production in M.T.	26.58	42.40	69.37	83.50	139.71	174.61

Fig. 2

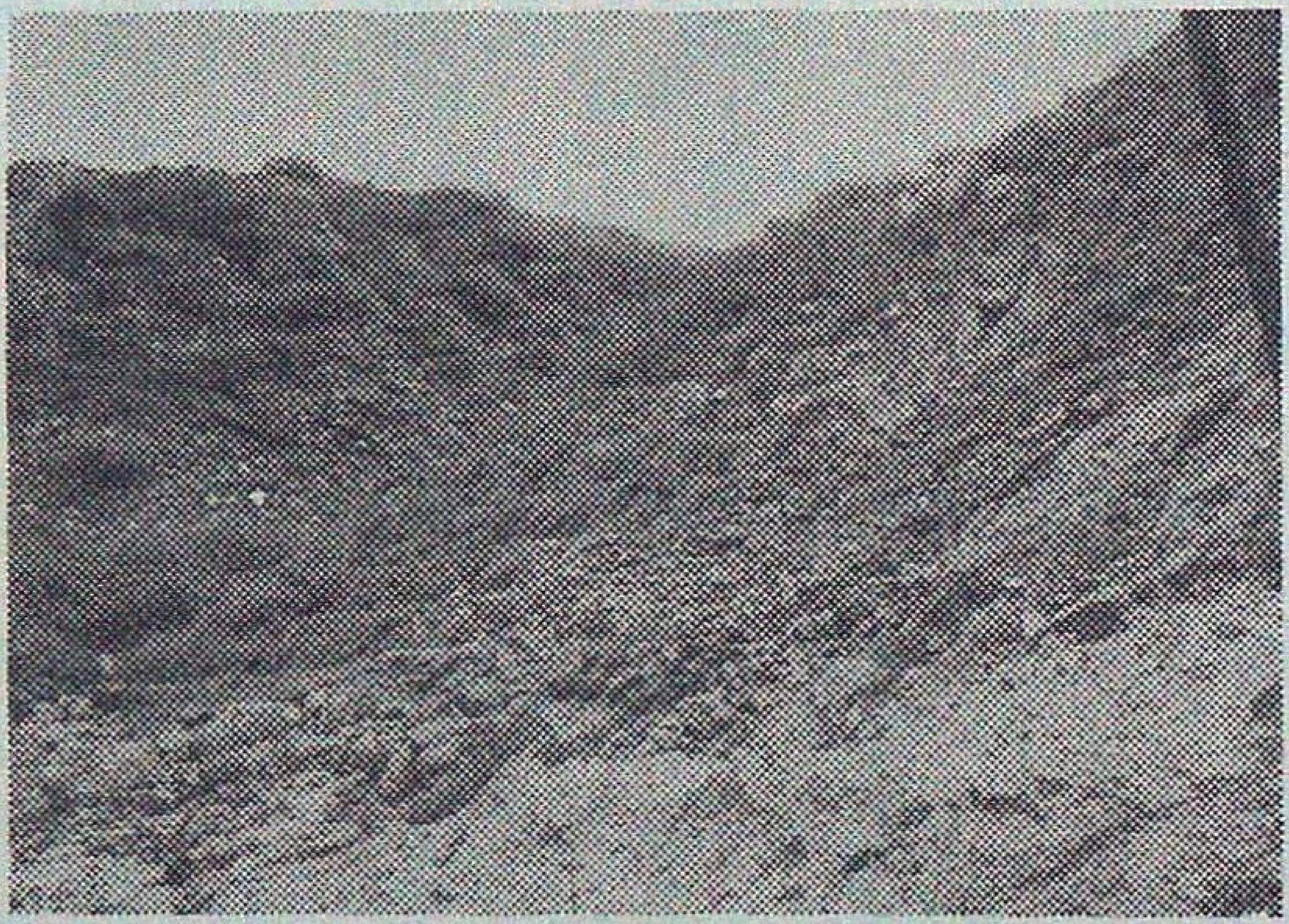
Over-burden after plantation

Fig. 3



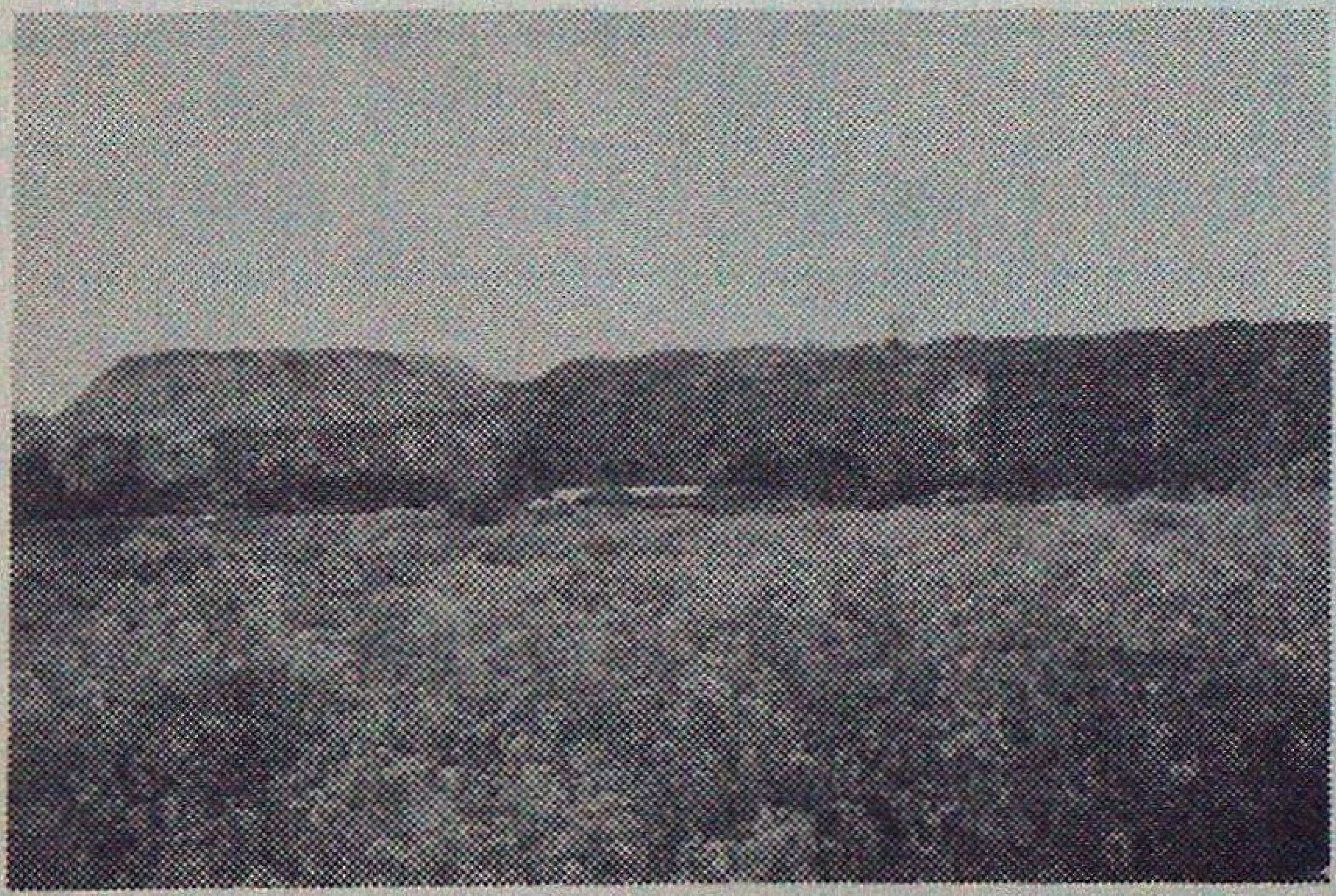
Over-burden after three months

Fig. 4



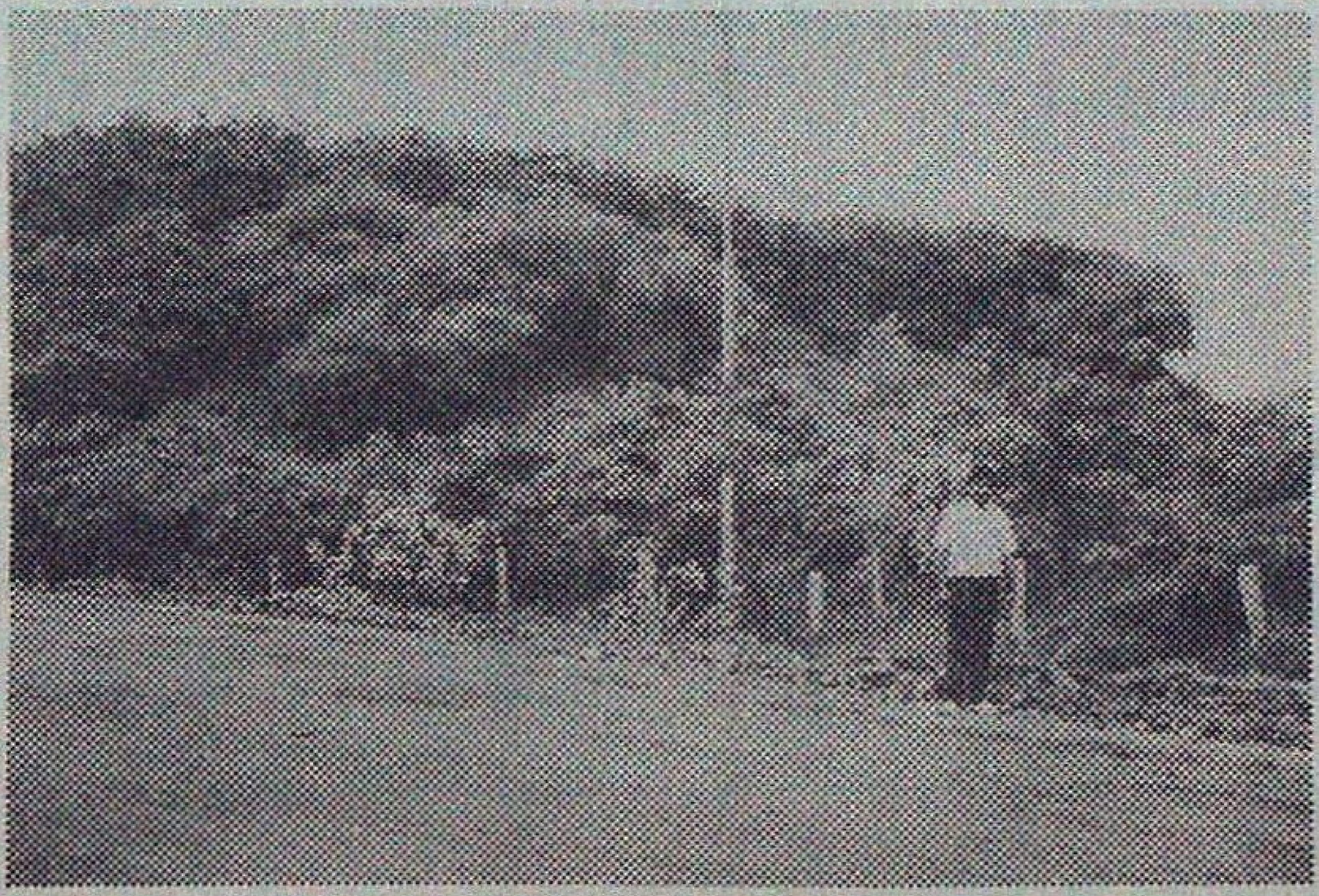
Over-burden after six months

Fig. 5



Over-burden after one year

Fig. 6



Over-burden after five years

Technique of plantation followed varied from site to site specially the O.B. undulating top and steep slopes.

Over the undulating O.B. tops pits of 0.60 m^3 were dug 2 m apart during winter. About 2 kg cowdung manure was added in each pit with refilling during May.

Planting of one year old seedling was done after onset of rain during July-August. Thalas of one metre diameter were made just after completion of planting to conserve all available moisture. One weeding was done during September and winter hoeing during December-January preferably after winter rains.

On the steep slopes grodany of 0.60 m width were made along the contours about 3 m apart, pits of 0.60 m^3 were dug at 2 m intervals. Addition of cowdung manure and planting was done as in O.B. tops. Sowing of leguminous seeds preferably tree species was also done but the results were not encouraging.

The average success of plantations after 3 years was more than 80% and expenditure per plant came to Rs.10/- to 12/- inclusive of maintenance charges of 15%. It is expected to get return of Rs. 50/- per plant after about 5 years.

The year-wise detail of plantations raised in various coal mines areas is given in Table 3. The average of coal and O.B. production is given in Table 4.

Conclusions

The efforts of plantation since 1983 were encouraging and stabilized the O.B. having complete cover of *Prosopis juliflora*, *Cassia siamea* and other species.

It is proposed to remove *Prosopis juliflora* having 5 m wide strips and re-plant the clear felled areas with tall plants of *Dalbergia sissoo, Albizia lebbek* and *Tectona grandis*. The floor of the O.B. will be covered the *Prosopis* coppice as understorey. Thus the O.B. will remain under vegetational cover throughout and yield fuel, fodder and small timber for local use and in turn will give some return to N.C.L.

SUMMARY

The paper deals with planting of suitable tree species and their results for rehabilitation of open cast coal mines in Singrauli region of Uttar Pradesh and Madhya Pradesh.

उत्तर प्रदेश और मध्य प्रदेश के सिंगरौली क्षेत्र में ऊपर खुली कोयला खदानों का पुनः संस्कार करना

श्याम लाल

सारांश

इस अभिपत्र में उत्तर प्रदेश और मध्य प्रदेश के सिगंरौली क्षेत्र में ऊपर खुली कोयला खदानों के पुनः स्संस्कार के लिए उपयोगी वृक्ष जातियां लगाने तथा उसके परिणाम दिए गए हैं।

MANGROVE AND TOURISM: MANAGEMENT STRATEGIES

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Introduction

Mangrove ecosystems exist in tropical coastal areas in all the continents (Linden and Jernelov, 1980). Often they are found as deltaic formations of rivers in the form of creeks, lagoons etc. Mangroves play the role of a nursery of a large array of finfish and shellfish (Linden and Jernelov, 1980). They are one of the most productive areas of the planet (Dawes, 1981). These unique ecosystems are under threat all over the tropical countries of the world from various sources, like over exploitation, pollution and excessive land reclamation. In Kerala about 70,000 ha were covered by mangroves, but now it is restricted to isolated insular stands of derelict mangroves, under the very great stress of anthropogenic disturbances (Ramachandran and Mohanan, 1987). In this paper an attempt has been made to explore the intimate relationship between two widely differing aspects, the mangrove ecosystems and tourism. Most often mangrove ecosystems in India are noted tourist centres. This can be attributed to the scenic beauty of mangrove locations, the water sporting facilities available and the secluded serene, atmosphere. The well known tourist resorts in India which are mangrove habitats include, Pitchavaram (Tamil Nadu), Sunderbans (West Bangal), Mandovi-Zuari (Goa) and Kumarakom (Kerala). These areas are excellent sites for the development of 'mangrove tourist resorts'.

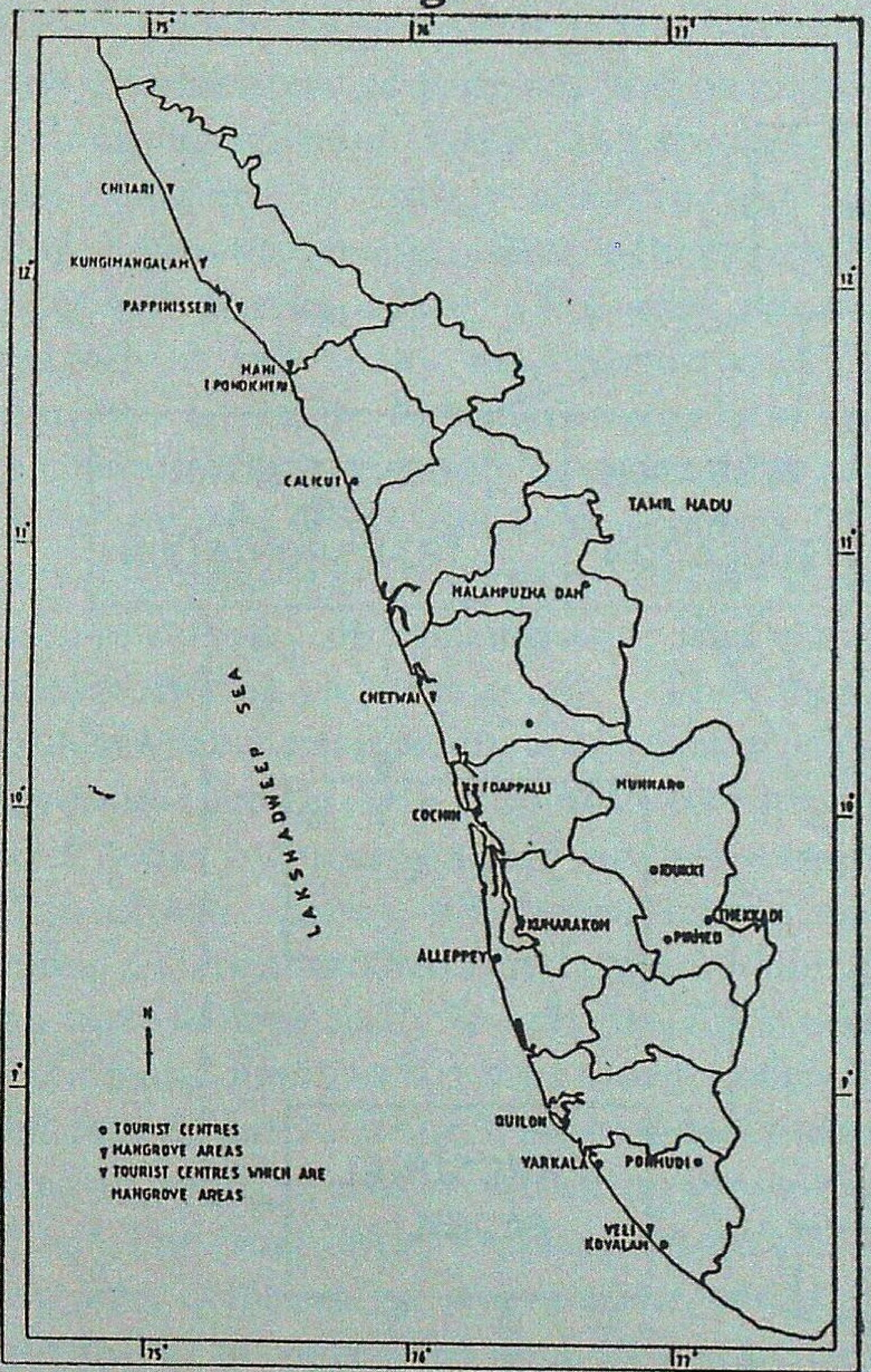
Materials and Methods

The scope for a proper management of mangrove ecosystems through the development of 'mangrove-resort' areas has been examined in a national level using suitable examples from Kerala. The various tourist resorts and important mangrove locations were listed and their role evaluated in the build-up of a mangrove-resort. Interactions between various components of tourism and mangroves were analysed by using of flow chart designs. A proper plan and guidelines were formulated for the management of mangrove-resort including a core area concept which will help to conserve the mangroves as well as to encourage tourism.

Results and Discussion

The Mangrove locations and major tourist resorts in Kerala : The tourist season in Kerala starts from September every year and extends to Febuary. The major tourist resorts in Kerala and the mangrove locations are shown in Fig. 1. It can be seen that out of eight important mangrove locations in Kerala three of them are well known tourist centres, viz., Veli (Thiruvananthapuram), Quilon and Kumarakom

Fig. 1



Map of Kerala showing major tourist resorts and Mangrove locations

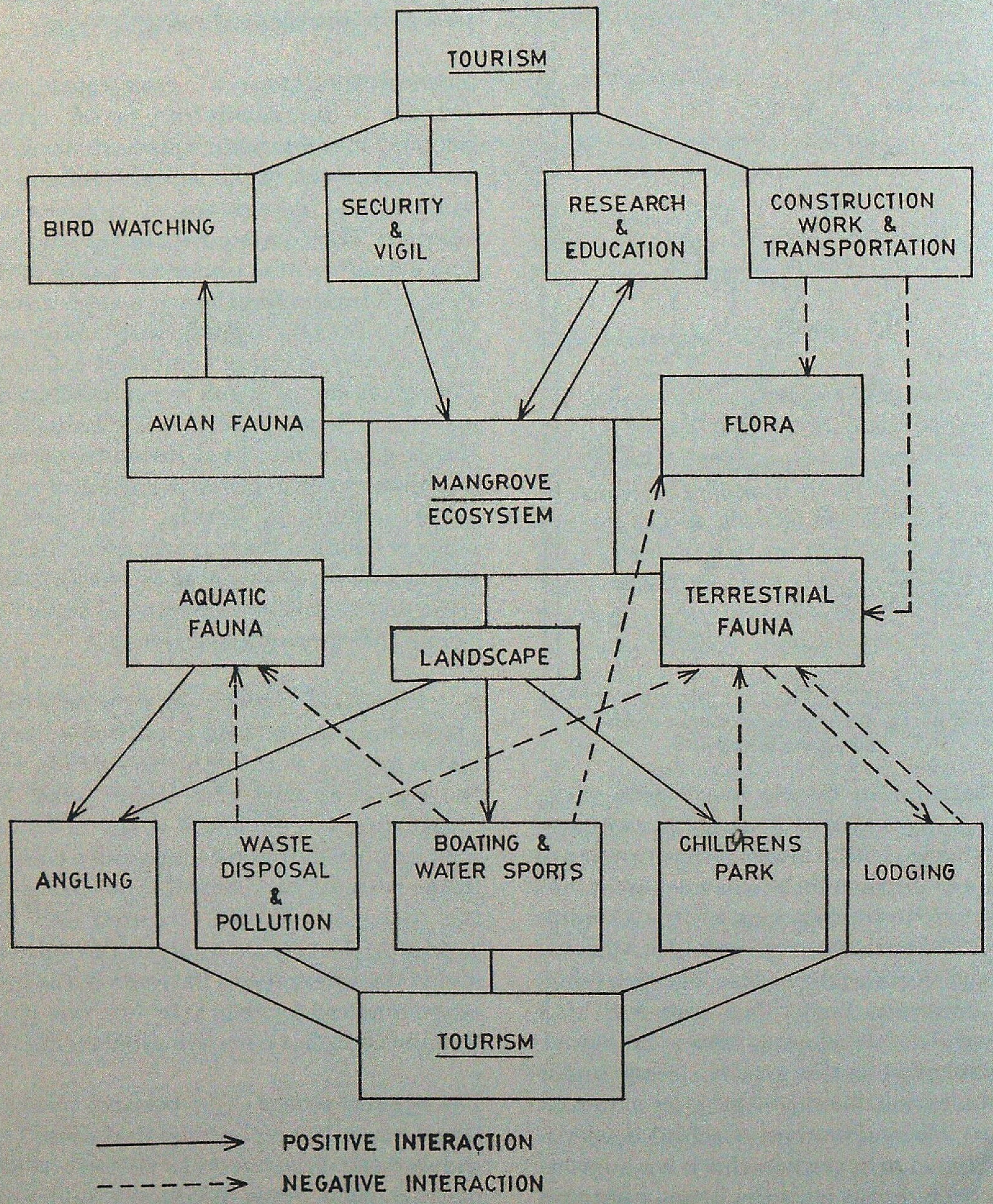
(Kottayam). In Kerala about 88% of the total mangrove area is under private control (Basha, 1991). Many of these areas are to be ear-marked for the development into a mangrove-tourist spot by the Government. The Pathiramanal Island in Alleppey District (Kerala) Supports a very few fringing mangrove flora. This area has high potential in developing into a mangrove tourist resort as this area is already under consideration for developing as a tourist resort. Mangalavanam (Cochin) deserves special mention because this is a mangrove area brought up with the prime intention to establish it as a mangrove-picnic spot. The main tourist attraction here is the peculiar rich mangrove avain fauna which is present throughout the year. Mahe which is under the Pondicherry administration is another area suitable for the development as a mangrove-tourist resort.

Interactions between mangroves and tourism : Ramachandran *et al.* (1985) adopted biocybernetic approach to chart out various interactions and feedbacks of tourism and mangroves at Kumarakom (Kerala). They doubted about the safety of this mangrove area under the hands of the Kerala Tourism Development Corporation (KTDC). They have put forward many useful recommendations, to protect the area. Though many of these recommendations are still to be implemented it is found that the mangrove habitat at Kumarakom is in healthier condition than many other mangrove habitats in Kerala. The present authors feel that there is an urgent need to augment the tree coverage by fresh plantations and recruiting a technical expert in the maintenance staff of the area.

Lloyd (1982) proposed, a model which places tourists visiting a particular area into a system, with both the tourists and the region as part of a larger area. By recognising the elements of the decision-making process which bring about a change in the area we can control that change to the benefits of both the area and the tourist. In the present analysis the authors divide the interactions between mangrove ecosystem and tourism into two, one positive and the other negative aspects (Fig. 2).

The positive aspects : In positive interaction it has to be emphasised that these two widely differing aspects of a nation's assets interact each other producing mutually benefiting self-regulatory structure earning income to the nation and helping conservation of natural resources. Ecological

Fig. 2

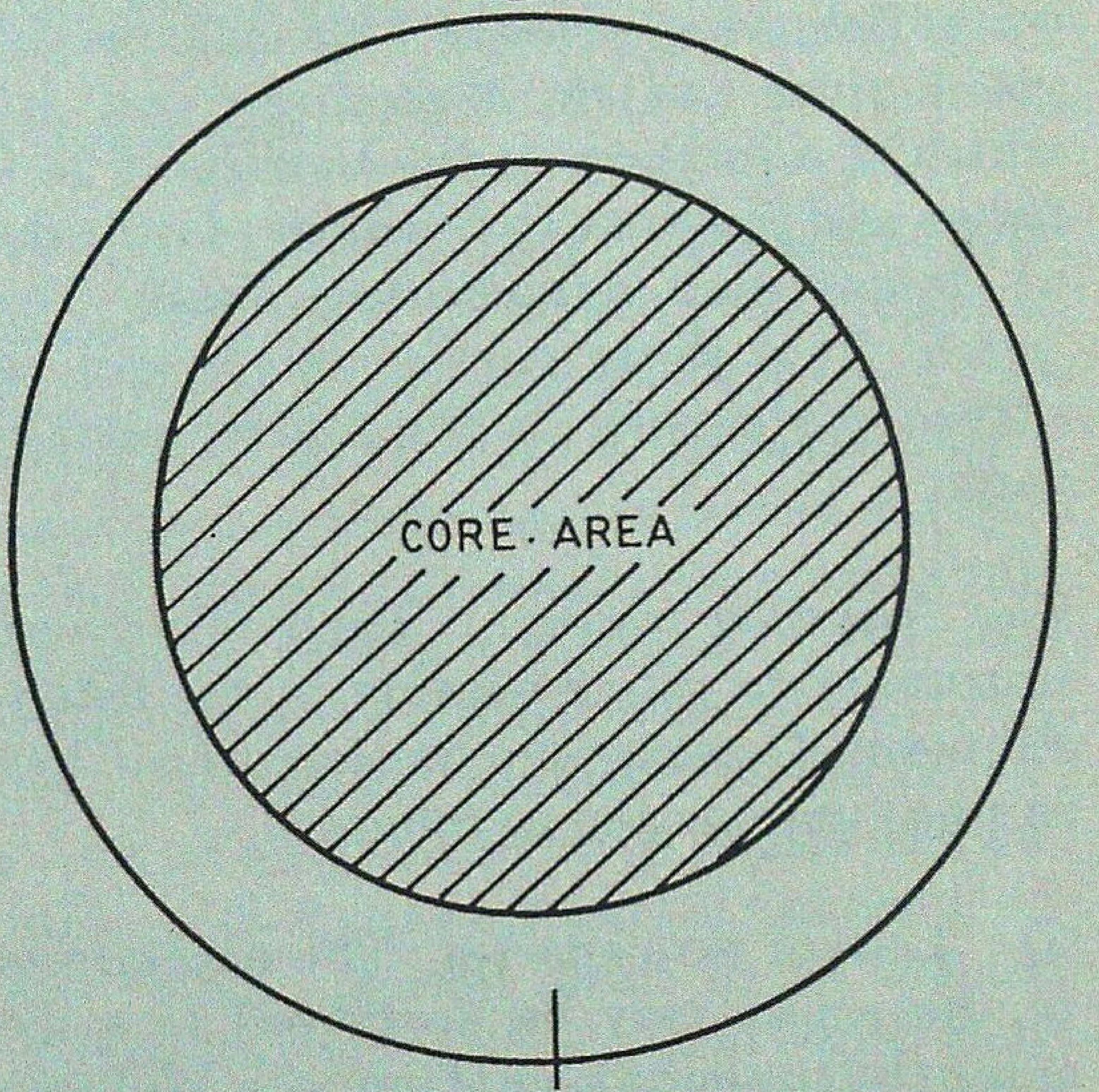


Interaction between various components of Tourism and Mangrove Ecosystem.

tourism or 'eco-tourism' is a new concept developed in Germany. It is the harmonious co-existence of tourism and ecological principles without destroying the ecological balance or rather encouraging eco-development through mass-education and peoples' participation. Like-wise we can introduce the term 'mangrove-resort' to denote the union between mangrove and tourism, which can help conservation and development of mangrove ecosystem. The development of such system will lead to the conservation of mangrove and other deteriorating ecosystems. The basic criteria for conservation is education of the masses through all available techniques and tools by encouraging nature camps, film shows, press, electronic media and mass awareness through devotional songs on nature especially in schools. Such education and mass awareness more especially among children is the best and most ideal way to begin this exercise at the grass-root level. The ritualistic 'Vanamahotsava' that we are celebrating every year could be shifted to mangrove or such places instead of being celebrated in cities and urban areas where a few trees have survived.

As the mangrove areas are being converted into tourist resorts the administration can recruit officials to protect and monitor the mangrove species of flora and fauna by fresh plantation and zealously protecting those that are surviving. This can be done by ear-marking areas not to tres/pass by the tourist. The entire mangrove area can be divided into a core area, where most of the rare species of plants and animals occur, and a fringe area where tourists may be permitted (Fig. 2). The areas can be demarked using sign-boards and also by the natural creeks and water-ways in the area.

Fig. 3



Core Area Concept

In most parts of India mangroves are threatened by illegal felling of the trees. In Kerala the soil dredging from these areas can kill the mangroves ecosystem within the shortest time. All these activities endangering mangrove ecosystem can be prevented by the constant vigil which is a natural outcome in the establishment of a mangrove-tourist resort.

For the tourists the mangrove environment with its intervening water-ways, creeks and lagoons offers a splendid location for picnic, water sports, angling, bird-watching and more over observing the serene beauty of nature. The mangrove landscape with the meandering water-ways, small islands and creeks are ideal for boating. Mangroves are the habitats of the highly sought-out animals like the Bengal tiger and very rare species of plants and animals which would be a delight for the tourists. The mangrove waters are bestowed

with an array of fresh water and brackish water fishes and prawns. This includes the giant river prawn, *Macrobrachium* sp. which is a delicacy to the tourists. These fishes and prawns can be cultured in tanks or demarcated aquaculture areas. The 'catch' from these culture ponds can be served exclusively in the tourist restaurants.

The Negative aspects : There are some important negative aspects in the establishment of a mangrove-tourist resort. They can be summarised as follows :

(i) Loss of rare species : The mangroves in the areas may be destroyed to some extent by the activities of tourists. Walking through the mangrove area during low tides or construction of anchor piles for tourist boats etc. can destroy mangrove seedlings. Rare mangrove and associated plant species occurring in the area may be destroyed by tres/passers. Most of the impacts on vegetation are in the initial stages. Fragile species disappear and recovery is dominated by resilient species (Negi, 1990).

(ii) Oil pollution : The motor boats operated through the channels of mangrove system can be detrimental to the biotic components due to the spillage of oil in water. The oil and grease in the mangrove waters adversely affect the germination of seedlings (Jagtap and Untawale, 1980). The oil pollution after a certain limit can affect the aquatic biota as a whole in these systems.

(iii) Waste-disposal : As the number of tourists increase the waste disposal would be difficult. The sewage and other waste materials dumped into the system will seriously affect the environmental quality.

(iv) Construction works and reclamation etc : Any construction work, land reclamation etc. in the mangrove area will destroy the mangroves. Thus the construction of roads, buildings, fences, barriers etc. lead to the loss of mangrove trees.

(v) Poisonous snakes, insects etc : In most cases mangrove habitats are characterised the presence of poisonous snake, injurious insects and sometimes crocodiles and even man-eating tigers as in Sundarbans. This poses many problems for the tourists.

The balance sheet : There is ample scope for developing a full-fledged mangrove tourist resort, without either interfering with the ecological stability of the system or the deterioration of the environment. To overcome the drawbacks explained earlier the following guidelines may be followed. First of all, the authorities under whom the administration is entrusted should have an adequate knowledge about the fragility of the ecosystem, its importance in the national level and about the role of this particular ecosystem plays in the economics of tropical people. The tour conductors must be well educated, knowledgeable and if possible, conservationists. Destruction of rare species can be avoided by ear-marking such areas, providing public-education aids like boards showing scientific and local names of the plant species along with notes on their peculiarities and uses. In addition each tourist should be provided with a hand book which would indicate the major and conspicuous species with an assortment of names not too cumbersome for the tourists with an appendix indicating more details for him to follow in his subsequent visits. This will help to build-up a consensus among people about the conservation and the uses of mangroves. Also this will attract a section of tourists with scientific

curiosity. Providing special type of binoculars to the tourists will help them learn about the ecosystem without intruding into more inner areas. At the end of the tour which would extend half or a day, each one would become a conservationist and learn properly of the significance and consequences of conservation of this most fragile area which is undergoing tremendous degradation.

The oil pollution can be minimised by encouraging row-boats. Motor/mechanized boats should not be allowed to operate in the mangrove area because, they carry more people at frequent intervals and cause noise pollution. Also the waves originating from the boats can adversely affect the mangroves. Row-boats are preferred in such a system because it takes more time, carry less people, no noise or oil pollution and the animals, and plants left undisturbed.

Periodic sampling of water and its analysis for water quality and pollution levels will provide a clear picture. This is very important because correction measures should be taken up at each stage and in the extreme case whole resort area should be closed down.

Conclusion

The creation of a mangrove-tourist resort will definitely lead to the conservation of mangroves and also impart a new dimension to tourism. The mass-awareness programmers which are an integral part of the concept would clear many misconceptions about mangroves such as mangrove locations are the sites of vectors of diseases and not beautiful sights of very rare and unique species of plants and animals. In fact, they are part of nature which has been passed down to us through millions of years. Government legislations, though very useful, have not been found to be very effective from the point of conservation and it is here that programmes of mass awareness and peoples' participation become effective. The various interactions between the different aspects of mangrove ecosystems and tourism should be studied in detail and tourism should be studied in detail and judicial plan has to be chalked out to establish a harmonious co-existence between the two.

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SUMMARY

Mangrove ecosystems, despite their unique characteristics and multifarious uses undergo deterioration all over the tropical regions of the world. This paper focuses on the role of tourism in the conservation and maintenance of the mangrove ecosystems. A novel term, 'mangrove-resort' was suggested and criteria and guidelines for the development of such a system have been put forward. A perfect harmony between these widely differing aspects is possible, provided the administration is exellent and appropriate to the needs of both tourism and conservation of endangered ecosystems. In Kerala out of eight major mangrove areas three are noted tourist centres including the famous bird sanctuary, Kumarakom which is at present under the control of Kerala Tourism Development Corporation. Apart from these, Mangalavanam (Cochin) and Mahe (Pondicherry) are suggested for the development of 'mangrove-resort' areas. The interrelations between various components of the two systems with their feed-back interactions are discussed.

वायुशिफ और पर्यटन-प्रबन्ध की समरनीतियाँ

जार्ज थौमस व ट्रेसा0 वी0 फर्नांडिंस

सारांश

वायुशिफ परिस्थिति-संहति अपनी विलक्षण विशिष्टताओं और नाना प्रकार के उपयोगों के बावजूद संसार के उष्णदेशीय क्षेत्रों में सर्वत्र व्याहसित होती जा रही है। प्रस्तुत अभिपत्र में वायुशिफ परिस्थिति-संहति के संरक्षण और रखरखाव में पर्यटन की भूमिका पर ध्यान केन्द्रित किया गया है। एक नया शब्द वायुशिफ आश्रय सुझाया गया है तथा इस तरह का क्षेत्र विकसित करने की कसौटियां और मार्गदर्शक सिद्धान्त प्रस्तुत किए गए हैं। परस्पर भारी भिन्नता वाले इन दोनों पक्षों में पूर्ण समरसता लाना संभव है बशर्ते कि पर्यटन और विलुप्ति के खतरे में फंसी परिस्थिति-संहति दोनों की आवश्यकताओं के लिए उपयुक्त अत्युत्तम प्रशासन हो। केरल के आठ मुख्य वायुशिफ क्षेत्रों में से तीन क्षेत्र प्रसिद्ध पर्यटन केन्द्र हैं जिनमें प्रसिद्ध पक्षी अभ्यारण कुमारकोम भी है। इसका नियंत्रण इस समय केरल पर्यटन निगम के हाथों में है। इनके अतिरिक्त मंगलवनम् (कोच्चि) और माही (पांडिचेरी) भी वायुशिफ आश्रय बनाने के लिए सुझाए गए हैं। दोनों प्रणालियों के विभिन्न अगों के पारस्परिक संबन्ध और उनकी पश्चगामी अन्तक्रिया भी विवेचित की गई है।

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GENETIC IMPROVEMENT OF *DALBERGIA* SPECIES: PROBLEMS AND STRATEGIES

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Introduction

Dalbergia latifolia and *Dalbergia sissoo* are two of the important timber yielding trees of India. *D. sissoo* can be clearly considered as a deciduous tree while *D. latifolia* is a deciduous or nearly an evergreen tree. In India *Dalbergia* trees are found either in deciduous forests or in mixed deciduous forests. *D. latifolia* and *D. sissoo* thrive well in well drained deep moist soil. They are known to occur in neighbourhood of perennial streams. *D. latifolia* grows in a wide range of soil formations, but *D. sissoo* is mostly confined to alluvial formations.

The timbers of *Dalbergia* are unusually strong. The minimum exploitable girth of *D. latifolia* is 1.83 m. *Dalbergia* trees are slow in forming heartwood and old stems give fragrance and rich coloured timbers.

D. latifolia is an erect tree and grows to an immense size. Specimens of 4.57 m girth have been frequently reported. It is one of the tallest mountain trees in India. *D. sissoo* is often with crooked trunk and light crowns. Under favourable conditions it is known to attain a height of 30.48 m with girth upto 2.44 m. In terms of secondary xylem production the growth of rings produced by *D. latifolia* and *D. sissoo* are not distinctly marked. Both the species are known for their highly encarvable wood.

D. sissoo leaves are considered as a good cattle fodder. Palatability and nutrient content of leaves are highest in April-May. The heartwood of *D. sissoo* yields about 5% of light brown, non drying highly viscous fixed oil, which on cooling becomes semi-solid like vaseline, this is a suitable lubricant for heavy machinery.

D. latifolia and *D. sissoo* are well known for their coppicing nature. *D. sissoo* coppices vigorously upto the age of 20 years and gives profuse suckers. This unique trait of *Dalbergia* directly helps in the proliferation of species.

Geographical Distribution and Diversification

D. latifolia is found to be distributed in the sub-Himalayan tract from Oudh eastwards, Bihar, Orissa and Central, Western and Southern India. It is frequently found in association with Teak. It grows in a wide range of geographical formations such as gneiss, trap, laterite, boulder deposits and alluvial formations; it thrives well in drained soil. It is found to be distributed in the

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peninsular India including Godavary forests, Circar mountains, Malabar, Canara and Sunda regions. It is found in North-Eastern provinces of Bengal, the Khasia hills, Assam and on Coramandel and Malabar coasts (Balfour, 1870).

D. sissoo occurs throughout the sub-Himalayan region from Ravi to Assam. It is found indigenous along the foot hills of Himalayas. It is extensively cultivated in Punjab, Uttar Pradesh, Bengal and Assam. *D. sissoo* is found most typically in alluvial soil ground or on sand or on gravel, often gregarious. This tree is well adapted in porous soil with adequate moisture, with rainfall ranging from 750-4500 mm.

Botany and Wood Anatomy

D. latifolia is an erect tree, glabrous all parts, leaves 10-15 cm long, rachis straight, leaflets 0.5-2.5 cm long, 5-7 orbicular, obtuse; firm greenish or glaucous below, often emarginate at the base of the petioles, unusually long pedicels as long as the calyx (3-4 mm), teeth obtuse, rather shorter than the tube. Flowers in lax panicles with sub-corymbose branches. Stamens 9; corolla white, twice the length of the calyx; pods firm, 2.5-7.5 cm in length, shining in the place of the seeds distinctly marked but not wrinkled (Hooker, 1872).

Bark 8 mm thick grey with irregular short cracks, exfoliating in thin, fibrous longitudinal flakes. Wood extremely hard, close grained; sapwood yellow, heartwood dark purple with black longitudinal streaks; no distinct annual rings. Pores moderate sized to large, often subdivided, irregular, scanty in patches which are generally joined by narrow, white, wavy interrupted concentric lines which are regularly concentric. Medullary rays fine, numerous, uniform, equidistant and very short.

D. sissoo is an erect tree with finely grey branches. Leaf rachis zig zag, leaflets firm, glabrescent, 1-3 long panicles much shorter than leaves, the branches are densely pubescent, calyx 4.2 mm deep, downy, very short. Corolla yellowish, twice the length of the calyx; standard with a long claw petal and round limb. Stamens 9; pod thin strap shaped, pale brown, glabrous, 3.8-10.2 by 0.63-1.27 cm obtuse twice long as the calyx (Hooker, 1872). Leafless in January-February, the fresh foliage appears in March and the flowers soon after. The fruit ripens in November.

Bark 8-12 mm thick, wood very hard, close grained; sapwood white; heartwood brown with longitudinal veins. Annual rings not distinctly marked, pores large to moderate sized and scanty which are joined by fine way more or less in concentric streaks, which are frequently interrupted and often oblique (Gamble, 1881).

Rosewoods are generally slow in forming heartwood. But the wood is extremely hard and encarvable. While *D. latifolia* is known to form dark purple colored heartwood, *D. sissoo* produces light brown colored heartwood. There is no clearcut difference between the growth rings produced by the secondary xylem.

Floral Biology

D. latifolia produce white flowers in lax axillary panicles with sub-corymbose branches. The pedicels are as long as the calyx. The calyx is present with obtuse teeth. The corolla is white and is almost twice the length of the calyx. Stamens are 9 in number. *D. sissoo* produces yellowish flowers. The calyx 4.2 mm long and downy in nature with short teeth. The corolla is yellow in colour and it is almost twice the

length of the calyx, a long claw petal is present with a round limb, stamens 9.

No data is available on pollination biology with reference to the mechanism of pollinators and mating systems.

Cytological and Cytogenetical studies in *Dalbergia*

There are few reports concerned with the cytology of *D. latifolia*. Cytological studies were made in the plantlets and shoot buds derived from the hypocotyl explants. Squash preparation revealed that it contained mostly globular and oval shaped cells. The meristamatic zones had small cells with dense cytoplasm (Sudhadevi and Nataraja, 1981). The callus also contained several tracheidal cells with reticulate thickenings. Histological preparations of the differentiating callus showed that the organisation of shoot meristem occurred from the peripheral regions and each shoot but had distinct dome shaped apex flanked by leaf primordia.

The somatic chromosome number of *D. latifolia* and *D. sissoo* is 2n = 20 (Federov, 1974). The importance of polyploids in the genetic improvement of tree species has been well emphasised by Gotafsson (1960). It is always of interest to see that whether the tetraploids are superior to the diploids. Kapoor and Kedharnath (1970) reported the induction of tetraploidy in *D. latifolia* and *D. sissoo*. Chromosomal abnormalities were found to be associated with tetraploidy. Differences in size of stomata and the frequency of stomata were recorded. The change in structure and size and the number of the stomata was compared to that of the diploids. Leaf tip squashes of the tetraploids clearly showed the chromosomal abnormalities when compared to the control samples. The tetraploidy was induced by using varying concentrations of colchicine prepared in aqueous solution and 10% glycerol medium (Kedharnath, 1968).

Genetics and Breeding

No reports are available on the inheritance and genetics of wood characters. Also no attempt has been made to breed improved genotypes combining the important features of both the species and/or selecting superior genotypes from the intraspecific variability. However, preliminary investigations on the induction of mutation and the possibility of utilising mutation breeding technique has been investigated.

Among the chemical mutagens tried on plant systems Ethyl Methane Sulfonate (EMS) was found to be more effective with high mutagenic effectiveness as well as high mutagenic efficiency. EMS at concentrations ranging from 0.15%-1.00% at 3 pH level were tried in *D. sissoo* (Kedharnath, 1968). Seeds were treated for eight hours in each concentration and they were stirred intermittently with the temperature being controlled at 28 ± 1°C. The germinated seedlings were maintained in the laboratory under artificial illumination during the course of recording the observations on germination of the seed and height of the seedlings.

D. sissoo is sensitive to the chemical EMS and 50% reduction in germination can be obtained with a concentration of 0.6%. Among the physical mutagens, gamma rays was tried with *D. sissoo* seeds and the seeds were found to be radio resistant (Kedharnath, 1968).

Breeding for Disease and Pest Resistance

The disease caused by *Maravalia achroa* in *D. sissoo* is commonly referred to as a leaf rust. *Maravalia achroa* attacks leaves and young branches of *D. sissoo* seedlings in nurseries. Uredial pustules are yellowish and formed on the lower leaf surface. Telia are colourless and pulvinate. Wilt disease caused by *Fusarium solani* induces wilting, chlorosis and leaf drop in natural forests and plantations in sapling and at pole stages; ultimately plants are killed. No data are available on control, and/or on the extent and impact of disease incidence. Among the insects that attack *D. sissoo* common leaf defoliator *(Plaeoptera reflexa)* is the most serious pest.

Not much data are available on the pathological aspects in *D. latifoila*. Information regarding control aspect of disease incidence is almost nil. The common powdery mildew is known to occur in *D. latifolia* which is caused by *Phyllactina dalbergiae*. There are also reports of the incidence of leaf spot in *D. latifolia* which is caused by *Phyllosticta dalbergicola*.

Reports on the source of resistance to pests and diseases in both the species are not available. Also, no attempt has been made to breed disease resistant genotypes.

Biotechnological Aspects

Several aspects of tissue culture work has been carried out in *Dalbergia*. Both for *D. latifolia* and *D. sissoo* protocols for regeneration have been proposed and worked out. A wide range of plant growth regulators has also been recommended.

Organogenesis and plantlet formation in *D. sissoo* has been established (Suwal *et al.*, 1988). Areas under protoplast cultures and regeneration has also been worked out in *Dalbergia*.

Varietal responses of explant to the hormones has been reported from both *D. latifolia* and *D. sissoo*. Nodal explants derived calluses of *D. sissoo* were grown on media containing 2, 4-D, BAP, 2, 4-D+BAP TIBA and BAP + TIBA. Xylogenesis was stimulated by both 2, 4-D and BAP. However, some tracheary cells were present in the controls, which received no exogenous growth regulator (Datta and Pramanik, 1984). It is speculated that endogenous IAA may have induced some xylogenesis. TIBA (Tri iodo Benzoic acid), an antiauxin, reduced xylogenesis and also seemed to reduce the amount of endogenous IAA measured in the culture.

Auxin induced regeneration has also been reported in *D. sissoo* (Datta and Datta, 1983). Plantlets were successfully grown over 60 days using nodal explants taken from a mature tree and cultured in MS media fortified by various auxins such as IAA, IPA, NAA and 2, 4-D. Plantlets were successfully derived from media supplemented with IAA or IAA + NAA. With IPA and 2, 4-D the results were negative. Regeneration work for *D. latifolia* has been standardized by Sudhadevi and Nataraja (1981). Establishment of plantlets from the hypocotyl derived cultures is one of the possibilities for *D. latifolia* which calluses in the presence of 2, 4-D. Further more with fortification of kinetin + coconut milk in the media callusing was profuse.

Hypocotyl segments subjected to culture in NAA produced roots. The cytokinin, Benzyl amino-purene (BAP) was very effective in causing shoot bud formation.

Browning of the pale green hypocotyl segments occurred after 2 weeks of inoculation in Basal Medium (BM). Explants cultured on BM +BAP (0.25, 0.5, 1.0 and 2 mg/l) developed shoot buds. The shoot buds developed further and produced narrow leaves. When the isolated buds were allowed for a passage in NAA fortified media at a concentration of 1.0 or 2.0 mg/l. BAP seems to be effective in shoot bud formation in hypocotyl explants and callus cultures of *D. latifolia* but in case of root explant of *D. sissoo* auxin can be stimulatory to bud initiation at lower concentration (Mukhopadhyay and Mohan Ram, 1981).

Problems, Prospects and Future Strategies

D. latifolia and *D. sissoo* are the most important valuable timbers of India. Though the distribution is satisfactory, over exploitation is slowly making a deficit in the existing population. *D. sissoo* is an indegenous tree of India, especially to the foot hills regions of the Himalayas. The presence of it in the plains is only due to cultivation. It is now found in many places in the Northern India where it is not indegenous especially in irrigation tracts. But raising of these plants are subjected to only conventional procedures and no reports are available on the use of neotechniques for the development of the given vegetation.

The relativeness of both the species viz., *D. latifolia* and *D. sissoo* in floral features, formation of heartwood, coppicing, response to auxins in terms of rooting and adaptional features like capacity to thrive in water clogged porous soil indicate genetic differences.

However, no significant attempt has been made for the genetic amelioration of the species. Several reasons may be assigned for this.

1. Absence of basic information on reproductive biology, breeding systems, genetics and cytogenetics about the species.

2. Complex genetic structure including long generation cycle.

3. *Dalbergia* mainly being an Asian species has been neglected by the resourceful research workers of the European countries.

4. Limited trained manpower available on forest genetics have not been properly utilized in the past.

Implementation of the conventional techniques must help for the survival and further exploitation of the species. Though conservation either *ex-situ* or *in-situ* can be made for *D. latifolia* the other species *D. sissoo* can be recommended for further more cultivation. It is known that both the species respond well for the rooting with exogenous application of growth regulators such as auxins. Thus, conventional techniques such as developing plant from hardwood cuttings can be standardised with utility of auxins such as IAA, NAA, IPA and IBA.

Tissue culture of forest trees in general and *Dalbergia* in particular has lagged behind that of many agricultural crops. The recent reviews (Bonga and Durjan, 1982; Datta and Pramanik, 1984; Thorpe and Biondi, 1981) on *in-vitro* culture of trees reveal the following reasons.

1. The long cycle of the trees.

2. Explants to be used from mature trees can only be obtained from field grown rather than greenhouse resulting in uncontrolled physiological variations.

3. Because of out breeding nature genetic variation in trees is generally greater resulting in unpredictability in the experiments.

4. Tissue from the mature trees are often non-responsive in culture; and

5. Inhibitory effect of oxidised polyphenols from the cut ends of the excised explants.

Several species of forest trees can be now regenerated by a septic culture techniques with different procedures adopted for each species. Fortunately legumes like *Dalbergia* have responded positively in *in-vitro* propagation. There are also few reports on somatic embryogenesis of tree tissue systems. With standardisation and success in somatic embryogenesis the scope of clonal propagation can be ensured. A few reports on the induction of haploidy in trees is of special relevance for tree improvement because it can help circumvent the long period required to produce a homozygous line by continuous breeding.

Production of intra and interspecific hybrid lines will likely be achieved through protoplast procedures. Gene addition should extend life of many of our most important plants and enable them to be used in different and more marginal environments. It may also significantly reduce the scale of plant breeding programme.

Though the propagation through both hardwood cutting and tissue culture help in maintaining genetic integrity of the species and increasing population of the species, such techniques will have limited application for want of superior genotypes. For developing such genotypes all efforts must be directed to use the classical plant/tree breeding methods based mainly on Mendelian genetic principles. Technique of protoplast fusion also holds promise in this respect. The detection at gene level may reveal the pathways mediating the wood formation, productivity, increase in bole length, girth of wood etc. Further manipulation in terms of techniques and wise application of these will bring fruitful results for the improvement and betterment of *Dalbergia* species.

SUMMARY

Dalbergia latifolia and _Dalbergia sissoo_ are two of the important timber yielding leguminous trees of India. They are known to occur in deciduous and mixed deciduous forests. They are well adapted to water clogged soil. Both the species are very well known for their coppicing nature which indirectly helps in the propagation of the species. Not much information is available on the genetics, breeding, floral biology aspects of the species. Biotechnological manipulation in terms of tissue culture and protoplast studies have been made and both species have responded positively. It is emphasised that further approaches in disciplines such as cytogenetics, genetics, breeding and biotechnology shall pave the way for betterment of the species.

डलबर्गिया की जातियों का जननिक परिष्कार-समस्याएँ एवं समरनीति

ए0 के0 मण्डल, के0 एन0 सुब्रामनियन व बी0 नागराजन

सारांश

डलबर्गिया लैटिफोलिया और *डलबर्गिया सिस्सु* भारत की दो महत्वपूर्ण शिम्बिवर्गिय प्रकाष्ठ-प्रदायी वृक्ष जातियाँ हैं। पानी से अवरुद्ध हुई मृदाओं में भी ये अनुकूल बन गई हैं। दोनों जातियाँ स्थूणरुह प्रकृति के लिए भली-भांती ज्ञात है जो परोक्षत। इन जातियों के प्रवर्धन में भी सहायक बनती है। इन जातियों के जाननिकी, प्रजनन, पुष्पजैविकी पक्षों के बारे में अधिक जानकारी नहीं मिलती। ऊति संवर्धन और प्ररसक अध्ययन जैसे जैव-प्रौद्योगिकीय कार्य किए गए है और दोनों जातियों का प्रतिचार धनात्मक रहन है। इस बात पर बल दिया है कि कोशाजननिकी, जननविज्ञान, प्रजनन और जैवप्रौद्योगिकी जैसे क्षेत्रों में आगे काम करने से इन जातियों में सुधार लाने का मार्ग प्रशस्त हो जाएगा।

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EFFECT OF NAA, IBA AND KERADIX ON ROOTING POTENTIAL OF *RHIZOPHORA APICULATA* BLUME HYPOCOTYLS

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Introduction

Rhizophora apiculata, a mangrove species often exhibits poor rooting of hypocotyls, resulting in inefficient establishment of seedlings in muddy and loose substrated of the mangrove environment (Kathiresan and Thangam, 1989, 1990 a, b; Kathiresan *et al.*, 1990). Hence, an attempt has been made to improve rooting of the mangrove hypocotyls by application of some chemicals, which have been already reported to be the root promoting substances in non-mangrove plants (Sarma and Bardoloi, 1990).

Materials and Methods

Viviparous hypocotyl of *Rhizophora apiculata* Blume was collected during January 1992 from Pichavaram mangrove forest (Lat. 11°27' N; Long. 79° 47' E) south-east coast of India, Tamil Nadu. The hypocotyls were given treatment separately in 500 ml beakers containing 250 ml of the test solution under darkness at 27 ± 1°C. The test solutions were prepared using seawater (salinity 15 g/l) with Indole-3-Butyric Acid (IBA), Naphthalene Acetic Acid (NAA) (Sigma chemicals, USA) and Keradix (Westcoast Rasayan International Pvt., Ltd., Bombay). From the pilot experiments, a range of concentrations and time of exposure, suitable for root promotion were determined. Treatment with NAA and IBA were given for 6 and 24 hrs respectively at 2, 4, 6, 8 ppm and that with Keradix for 3 hrs at 1, 0.1, 0.05 and 0.001% (w/v). Control hypocotyls were maintained in 15 ppt seawater. After treatments, the hypocotyls were transferred to the inter-tidal area of the Vellar estuary (Lat. 11° 29' N; Long 79° 46' E) (Salinity 25 ± 2 ppt). Five replicates ten hypocotyls each, were maintained for each treatment. After 15 days of planting, root growth characteristics were recorded. Protein content (Lowry *et al.*, 1951), Calorific value (Brody, 1945) of root were determined.

Results and Discussion

The data shown in Table 1 indicate that the rooting was poor in untreated hypocotyls of *R. apiculata* and was improved in response to the treatments. IBA and NAA enhanced rooting at lower concentrations. IBA, at 2 ppm in 24 hr of treatment, improved number of roots to the tune of 46%, root length to 46%, secondary roots to 53%, root protein to 2% and root energy to 121 cal/g. Similar promotory effect of IBA has already been reported in *R. apiculata*, when treated throughout the period of growth at lowest concentrations (Kathiresan *et al.*, 1990). The NAA, at 2 ppm in 6 hr of treatment, increased 70% of root number, 72% of length, 42% of second-

Table 1

Rooting characteristics of R. apiculata as influenced by IBA, NAA and Keradix

Treatment	No. of roots/ hypocotyl	Total length of root/ hypocotyl (cm)	No. of secondary roots/ hypocotyl	Root protein (% of fresh wt)	Root energy (cal/g of fresh wt)
Control (24 hr treated in water)	8.2	46.5	116.7	13.4	757
IBA 2 ppm	12.0	67.9	133.0	15.4	878
4 ppm	10.0	60.4	125.0	15.1	853
6 ppm	9.6	54.0	110.4	15.0	849
8 ppm	9.0	51.8	81.0	14.5	819
CD at 5%	2.1	12.0	9.1	1.0	50
Control (6 hr treated in water)	8.0	51.5	108.6	13.1	740
NAA 2 ppm	13.6	88.0	173.0	16.6	937
4 ppm	11.6	76.2	163.6	15.8	892
6 ppm	11.4	71.3	140.0	14.9	841
8 ppm	10.5	70.6	137.6	14.7	830
CD at 5%	2.4	18.2	31.1	1.5	105
Control (3 hr treated in water)	9.6	49.8	75.0	12.1	680
Keradix 0.001%	9.2	56.5	71.4	11.0	621
0.05%	11.0	56.7	89.0	13.6	768
0.1%	12.0	59.9	96.4	16.3	920
1.0%	16.8	67.6	99.4	18.0	1010
CD at 5%	0.4	6.8	4.5	2.1	20

ary roots, 3.5% of root protein and 191 cal/g of root energy, as compared to control. The commercial product, Keradix was found effective at higher concentrations, contrary to IBA and NAA which were effective at lower concentrations. The Keradix, at 1% in 3 hr of treatment, enhanced 75% of root number, 36% of root length, 20% of secondary roots, 5.9% of root protein and 337 cal/g of root energy.

Among the chemicals tested, Keradix enhanced maximum number of roots, root protein and energy; NAA increased maximum number of secondary root, length of root. Although the promotory effect of NAA (Chauhan and Sehgal, 1982) and Keradix are known in some terrestrial plants, such report in the viviparous seedlings is reported here for the first time. Also the treated hypocotyls easily got adapted in the natural environment. Moreover, it is a simple practice and costs only about 10 paise for NAA and IBA and two rupees for Keradix for treating 100 hypocotyls. Hence the treatments will be cost effective for better establishment of mangrove seedlings.

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SUMMARY

Effect of growth promoting substances on rooting of *Rhizophora apiculata* hypocotyl was studied in the intertidal areas of the Vellar estuary of Porto Novo marine environment. IBA and NAA were found promotory at lower concentrations less than 6 ppm and Keradix at higher concentration above 1%. NAA at 2 ppm in 6 hours of treatment and Keradix at 1% in 3 hours of treatment, induced maximum rooting characteristics and the treated hypocotyls easily got adapted to the natural conditions.

राइजोफोरा एपिकुलाटा ब्लूम0 के अधोबीज-पत्रों में जडें निकलने की संभावनाओं पर न्यूक्लिइक एसेटिक अम्ल, इण्डोल ब्यूटरिक अम्ल और केराडिक्स का प्रभाव

के0 कथिरेसन व पी0 मूर्ति

सारांश

राइजोफारा एपिकुलाटा के अधोबीज-पत्रों में जडें निकलने में वृद्धि प्रेरक पदार्थों के प्रभाव का अध्ययन पोर्त नोवो पर्यावरण के नेल्लर नदी मुख के अन्तर-ज्वार में किया गया। इण्डोल ब्यूटरिक अम्ल और न्यूक्इक ऐसेटिक अम्ल 6 भाग प्रति दस लाख भाग पानी से कम सकेन्द्रणों में मिलाकर तथा केराडिक्स 1 से उच्चतर संकेनद्रणों में, न्यूकिइक ऐसेटिक अम्ल 2 भाग प्रति दस लाख भाग पानी में मिलाकर 6 घंटे तक उपचार करने पर तथा केसाडिक्स 1% तीन घंटे तक उपचार करने पर प्रेरक पाए गए और इसके अधिकतम जडें निकलना प्रेरित हुआ तथा उपचारित अधोबीजपत्र जल्दी प्राकृतिक दशाओं के अनुकूल बन गए।

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COMPATIBILITY STUDIES ON *ACACIA TORTILIS* AND *ZIZYPHUS ROTUNDIFOLIA* WITH FIELD CROPS UNDER ARID CONDITIONS

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Introduction

Growing of trees along with annual crops is a sound practice and holds special promise in arid zone. Besides maintaining soil fertility on a sustained basis and conserving soil moisture longer, this practice has a potential of meeting the demand of fuel, fodder and food simultaneously. However, due to differences in growth behaviour and resources requirement of trees and crops, interaction between the two is bound to occur. Tree being the dominant component, its architecture significantly influences productivity of the understorey crop. The yields of pigeonpea, pearlmillet and groundnut crops grown under shelterbelt conditions (Rao, 1980) and that of pearlmillet fodder under *Prosopis cineraria* plantation (Singh, 1987) has been reported to be significantly higher than the open field. Similar increase in yields of millets (Felker, 1978), maize and sorghum (Poschen, 1986) under *Acacia albida* canopy was observed.

On the contrary, inhibition in yields of crops grown under tree canopy has also been reported. Deleterious effect of *Acacia nilotica* and *Dalbergia sissoo* was observed by Sheikh and Haq (1973). Considerable reduction in yield of clusterbean grown under unlopped *Holoptelia integrifolia* tree was reported by Muthana and Arora (1977). Shekhawat *et al*. (1988) recorded 44, 49 and 43 per cent reduction in yields of pearlmillet, cowpea and clusterbean respectively grown under 15 year old plantation of *Acacia tortilis* compared to the sole crop. Such reductions in yield are resulted due to competition between tree and crops for growth resources such as nutrients, moisture and radiant energy.

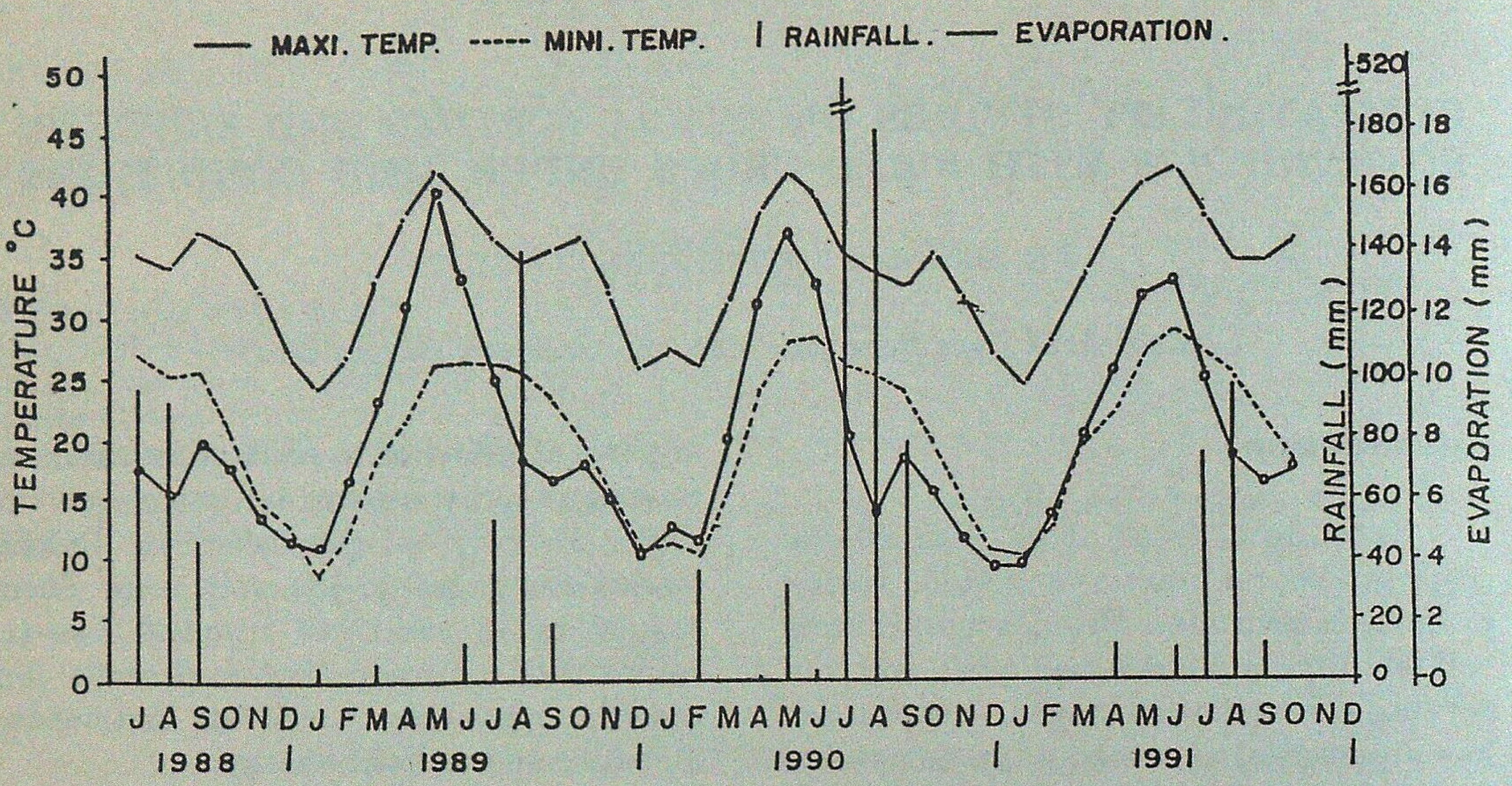
In view of the above, a feild study was undertaken to evaluate the mutual compatibility of some important trees with crops.

Materials and Methods

The study was conducted at Central Research Farm of Central Arid Zone Research Institute, Jodhpur for 4 consecutive years (1988-1991). Important physico-chemical properties of the soil and weather parameters prevailing during the study period are presented in Table 1 and Fig. 1 respectively.

Six months old seedlings of uniform height of two prominent tree species viz. *Acacia tortilis* and *Zizyphus rotundifolia*, were planted at 5 x 5 m spacing in the month of July in 1988. There were eleven rows consisting of 5 trees of each species in each row. Thus 55 trees of one species consituted one block. One block was left as control (without tree). In between the two rows of each tree species, pearlmillet (*Pennisetum americanum* c.v. WCC-75) and

Fig. 1



Mean monthly weather conditions during the experimental period

Table 1

Important physico-chemical properties of soil

Properties	Soil depth (cm)			
	0-15	15-30	30-60	60-90
Sand %	85.0	82.8	80.0	78.0
Silt %	5.7	7.0	7.0	4.0
Clay %	8.2	9.3	13.0	17.0
Bulk density g cm^{-3}	1.50	1.45	1.45	1.40
% moisture at 0.3 atm	7.4	8.2	10.5	10.5
% moisture at 15 atm	2.7	3.0	4.0	4.5
Soil pH	7.8	8.0	8.0	8.0
Total N %	.023	.02	-	-
Av. N kg ha^{-1}	100	80	-	-
Av. P (ppm)	5.0	3.0	-	-
Av. K (ppm)	60	50	-	-

clusterbean (*Cyamopsis tetragonaloba* c.v. Maru guar) were sown in 4 m wide alleys at 50 cm row to row distance in the kharif season of every year after a sufficient shower of rain was received. Thus the actual cropped area was about 80%. For comparison of yield data, two alleys of each species were left as control (no crop). The experiment was laid out in Randomised block design with two replicates.

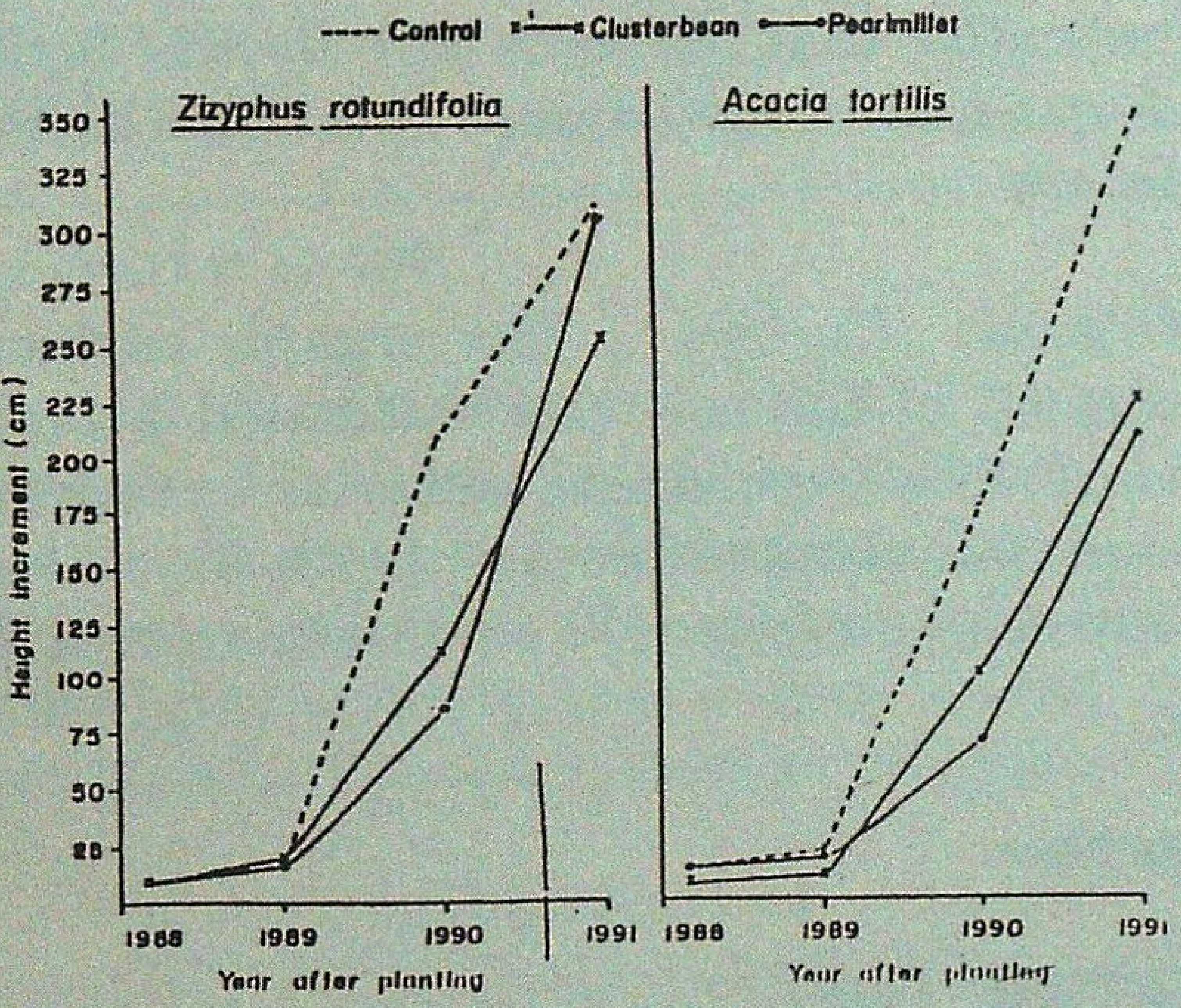
The crops were harvested at maturity and yields of grain and straw were recorded. Soil moisture was estimated gravimetrically at the time of harvest of each crop. Periodical observations on tree growth were made. In order to ascertain the build up of organic matter in the soil, samples taken after four years of experimentation were analysed following Walkley and Black method (Jackson, 1967).

Results and Discussion

Tree Growth : The annual increment in tree height over the initial (taken three months after the trees were established) depicted in Fig. 2 showed maximum growth of both the tree species when raised

without crop (control) obviously due to absence of any competition for growth resources. However, when grown in association with crops the magnitude of height increment decreased. The height of *Z. rotundifolia* followed the order : Control > Pearlmillet > Clusrterbean. The canopy diameter in the control was 433.8 cm but reduced to 268.8 cm in clusterbean and further to 185.9 cm in pearlmillet.

Fig. 2



Cumulative increment in tree height over the initial

The height increment of *A. tortilis* was also maximum while growing alone (without crop) and decreased in association with crop but the order followed was : Control > Clusterbean > Pearlmillet. The canopy diameter also follwed the trend similar to *Z. rotundifolia*. It was 509.8 cm, 363 cm and 285.5 cm in the control, clusterbean and pearlmillet association, respectively.

Crop yeilds : The grain and straw yields of pearlmillet and clusterbean crops were higher under control (sole crop) than those grown in association with trees but the differences were statistically non-significant during initial three years (Table 1). In the fourth year, although the yield levels were low due to erratic rainfall (Fig. 1) treatment differences were significant. It appears that the height and canopy of the tree attained in three years was not sufficient to interfere with crop growth. However, as the tree grew further they offered competition with the crops. In the subsequent year, the association of either pearlmillet or clusterbean with trees significantly reduced the yield of crops over the control (sole crop). The decrease in grain yields of pearlmillet was 83 and 66 per cent under *A. tortilis* and *Z. rotundifolia* repectively, while the corresponding decrease in straw yield was 36 and 26 per cent. The magnitude of reduction in yield of clusterbean was still more being 46% in straw and 74% in grain when in association with *Z. rotundifolia*. The reductions in yeild of clusterbean under *A. tortilis* were 92 and 96 per cent in straw and grain respectively. Similar reductions in yeilds of clusterbean and pearlmillet were also observed on loamy sand soils of Gujarat (Anon. 1991).

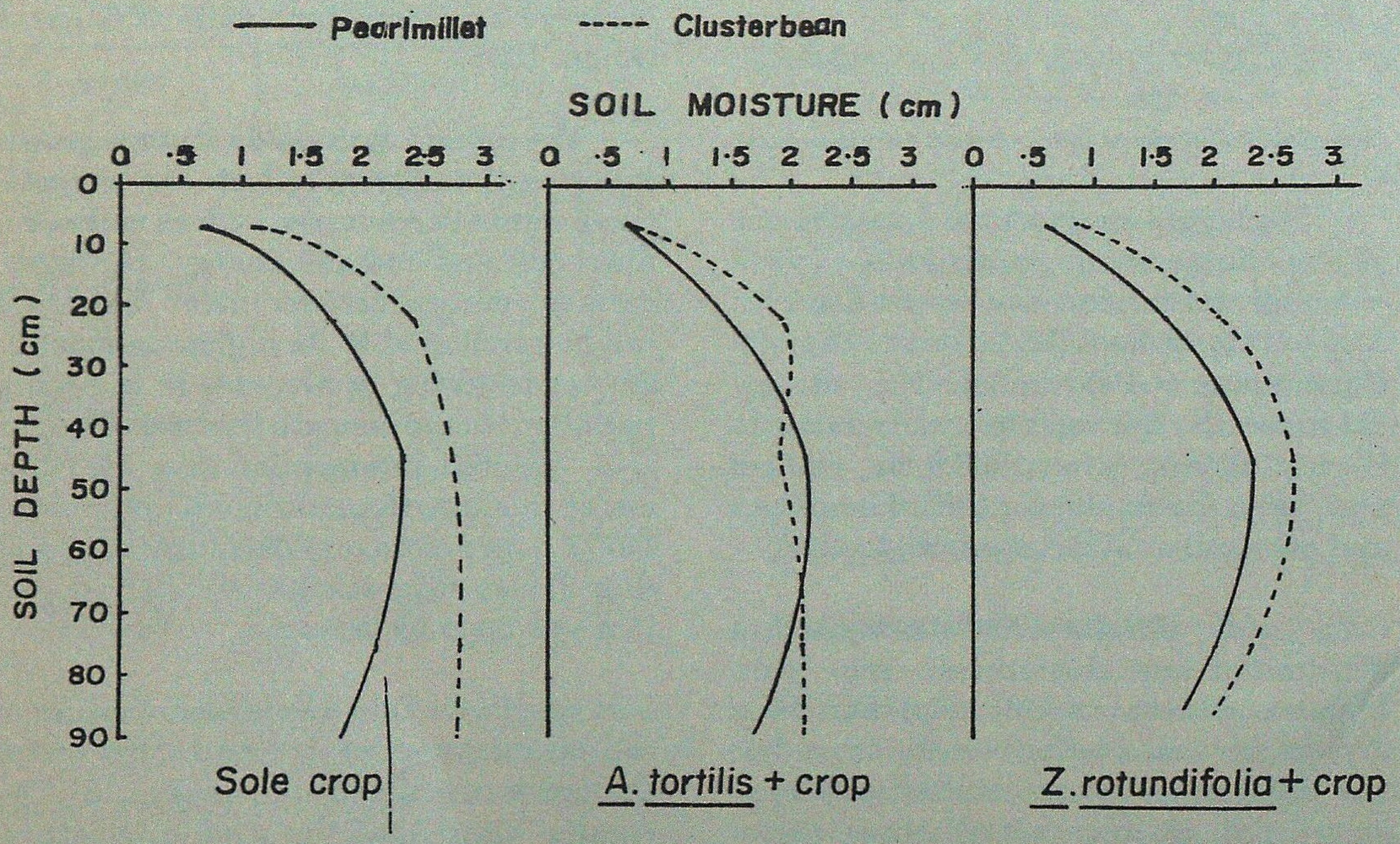
The reduction in yields of crops grown in association of trees reflects the competition for growth resources such as moisture, nutrients and radiant energy. However, greater yield reductions under *A. tortilis* can be atrributed to its higher canopy diameter resulting in decrease in incoming radiation to crop beneath this tree. The per cent rainfall interception was also low under this tree (Ramakrishna and Sastri, 1977). Lower storage of moisture in the soil (Fig. 3) also suggests that moisture depletion was more by this tree.

Soil moisture : Four years mean values of soil moisture profiles observed at harvest of the crops are illustrated in Fig. 3. The results show that the profile moisture-storage in *A. tortilis* was lower than

Z. rotundifolia and in pearlmillet (sole crop) than clusterbean (sole crop). Moisture storage decresed when the crops were grown in association with tree. Moisture storage in 90 cm profile under sole srop of clusterbean was 9 cm which decreased to 8 cm under *Z. rotundifolia* assosiation and further to 6.7 cm under *A. tortilis* association. This shows that the water utilization under clusterbean - *A. tortilis* combination was more. The observed lower profile moisture storage in pearlmillet, sole crop or in association with trees, as compared to clusterbean indicate the greater water use by this crop. Further, moisture storage in pearlmillet in combination with trees, either *A. tortilis* or *Z. rotundifolia*, was more or less similar but always lower than the sole crop. In case of clusterbean, sole crop and in combination with *Z. rotundifolia*, exhibited higher moisture storage than pearlmillet throughout the profile. But in association with *A. tortilis* the differences between the two crops were not discernible. Higher moisture storage under clusterbean, sole or in combination with trees, may be because of higher organic matter content which enhance the moisture storage capacity of soil. A perusal of the soil moisture data presented in Fig. 3 reveal that the stored moisture in top 30 cm soil layer under two tree species was similar while beyond this layer it was lower in *A. tortilis*. This is an indication that the roots of *A. tortilis* went deeper and extracted more water from lower layers.

Organic Carbon : The organic carbon content of the soil was estimated before start of the experiment and after 4 years of experiment upto 90 cm soil depth. Since the differences beyond 30 cm depth were not

Fig. 3



Average soil moisture profile at crop harvest

Table 2

Crop yield (kg ha^{-1}) grown in association with tree species

	Straw				Grain			
	1988	1989	1990	1991	1988	1989	1990	1991
			Pearlmillet					
Acacia tortilis	2190	1091	894	897	-	740	237	9.7
Zizyphus rotundifolia	2055	1230	1014	1146	-	790	270	19.2
Control (sole crop)	2164	1400	1114	1479	-	887	277	56.9
C.D.	NS	NS	NS	263.24**	-	NS	NS	11.55**
			Clusterbean					
Acacia tortilis	2602	476	2219	32.7	292	291	1125	0.67
Zizyphus rotundifilia	2409	467	2494	272.3	241	281	1125	4.76
Control (sole crop)	2879	530	2719	500.0	310	322	1288	18.63
C.D.	NS	NS	NS	185.3**	NS	NS	NS	3.37**

**Significant at 1% level.

well marked, the data only for first two layers of soil are reported. There was conspicuous increase in O.C. content of soil due to cropping over the initial values (Table 3). The magnitude of increase due to growing of clusterbean crop was more than that of pearlmillet. Clusterbean - *Z. rotundifolia* combination recorded maximum (135%) increase in organic carbon over the initial values. Higher amount of organic carbon in clusterbean as compared to pearlmillet can be ascribed to the greater leaf shedding.

Table 3

Organic carbon (%) content in soil after four years

Tree-crop combination	Soil depth (cm)		
	0-15	15-30	30-60
Initial (Before start of the experiment)	0.16	0.145	-
Pearlmillet - Sole crop	.266	.205	0.180
Pearlmillet - *A. tortilis*	.280	.202	.190
Pearlmillet - *Z. rotundifolia*	.282	.212	.168
Clusterbean - Sole crop	.354	.193	.197
Clusterbean - *A. tortilis*	.322	.224	.221
Clusterbean - *Z. rotundifolia*	.376	.251	.227

The results indicate that combination of *Z. rotundifolia* with pearlmillet or clusterbean is a better choice for agroforestry in arid regions. *A. tortilis* raised at 5 x 5 m spacing causes drastic reductions in yields of understorey crops primarily due to decrease in penetration of radiant energy through tree canopy and competition for soil moisture. Impact of trees on the understorey crops can possibly be minimised either by raising the trees at wider spacing (Debroy and Pathak, 1972) or regulation of tree canopy coverage through looping etc. as it has been observed in case of other tree species. However, this needs further investigations.

SUMMARY

The effect of growing pearlmillet and clusterbean crops in association with *Acacia tortilis* and *Zizyphus rotundifolia* on tree growth, crop yields, soil moisture and organic matter were ascertained for four consecutive years under arid conditions. The results revealed that the grain and straw yields of pearlmillet and clusterbean grown in association with trees decreased compared to sole crops. The reductions in yields under *Acacia tortilis* were more than *Zizyphus rotundifolia*. Clusterbean suffered greater reduction as compared to pearlmillet. Growth of trees was maximum in the control (Tree alone) while in association with the crops it decreased. Height increment in *A. tortilis* was more in association with clusterbean than that with pearlmillet while *Z. rotundifolia* attained greater height when in association with pearlmillet. Profile moisture stored at the time of crop harvest was maximum in sole crop of clusterbean and higher in clusterbean - *Z. rotundifolia* than clusterbean - *A. tortilis*. The organic matter content of soil after four years increased over the initial and followed the order : Clusterbean > Pearlmillet and *Z. rotundifolia* > *A. tortilis*.

शुष्क दशाओं में क्षेत्र फसल प्राप्ति के लिए *अकेसिया टोर्टाइलिस* और *जिजीफस रोटण्डिफोलिया* को साथ लगाने की संगतता के अध्ययन

बी० एम० शर्मा, एस० एस० राठौड़ व जे० पी० गुप्त

सारांश

अकेसिया टोर्टाइलिस और *जिजीफस रोटण्डिफोलिया* के साथ बाजरा और गुच्छा सेम उगाने का वृक्ष बृद्धि, फसल प्राप्ति, मृदा नमी और जैव तत्वों पर पड़ा प्रभाव जानने के लिए चार वर्षों तक शुष्क दशाओं में अध्ययन किया गया। परिणामों से पता लगा कि वृक्षों के साथ उगाने पर बाजरे और गुच्छा सेम के दाने और भूसे की प्राप्ति उन्हें अकेला करके उगाने की तुलना में कम हुई। *अकेसिया टोर्टाइलिस* की छाया में बाजरे की तुलना में गुच्छा सेम को अधिक घटत सहनी पड़ी। वृक्षों की वृद्धि नियामक (केवल वृक्ष) में अधिकतम रही जबकि फसलों के साथ उगाने पर यह घटी। बाजरे के साथ उगाने के मुकाबले में गुच्छा सेम के साथ उगाने पर *अ० टोर्टाइलिस* की ऊंचाई वृद्धि अधिक रही जबकि *जि० रोटण्डिफोलिया* को अधिक ऊंचाई बाजरे के साथ उसे उगाने पर मिली।

फसल कटाई के समय पार्श्ववत्र में जमा हुई नमी गुच्छा सेम मात्र फसल में अधिकतम तथा गुच्छा सेम- *अ० टोर्टाइलिस* के मुकाबले में गुच्छा सेम- *जि० रोटण्डिफोलिया* में अधिक रही। चार वर्ष बाद मृदा तत्व प्रारम्भिक जैव तत्व की तुलना में बढा तथा वह गुच्छा सेम > बाजरा और *जि० रोटण्डिफोलिया* > *अ० टोर्टाइलिस* क्रम में पाया गया।

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STUDIES ON TIME OF SEED COLLECTION, SOWING AND PRESOWING SEED TREATMENTS OF *TERMINALIA BELLIRICA* ROXB. AND *TERMINALIA CHEBULA* RETZ.

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Introduction

Terminalia, a large genus of mostly deciduous of trees and a few climbers is distributed in the tropical zone of Asia, Africa, America and can be exploited for plantations under social/agroforestry programs. It comprises 16 Indian species, all of which are trees, some of them reaching large dimensions. The climatic and other requirements of the species vary considerably.

Terminalia bellirica Roxb., is found in deciduous forests in a greater part of India, but not in arid regions. It is a common associate of Sal, Teak and other important trees, occurring more or less scattered. In the Indian peninsula, it occurs most frequently in moist valleys.

The timber is mainly used in house building as rafters, boards and also for packing cases. The timber is suitable for the manufacture of plywood and tea chests. The bark is useful in the treatment of anemia and leucoderma. The fruits are bitter, pungent, acrid and are used as a medicine for dropsy, piles, diarrhoea, leprosy and some other diseases (Kirtikar and Basu, 1975).

Terminalia chebula Retz., is found in a greater part of India in mixed deciduous forests extending into forests of comparatively dry type. It ascends upto an elevation of 1500 m, sometimes extending upto 1800 m. In Kangra Valley (H.P), it grows gregariously in rather stunted form on poor rocky sites upto about 1050 m elevation either pure or mixed with *Pinus roxburghii* Sargent, especially between Palampur and Maranda. In scattered form, it is also found in Bilaspur and Nahan Forest Divisions.

The timber is used for making posts, beams, carts and agricultural implements. The wood has been found suitable for the manufacture of good quality tool handles and is a good fuelwood. The tree is one of the principal tannin yielding species of commercial importance. The fruits are extensively used as adjuncts to medicines.

Both these species are of social forestry importance, but meagre scientific information is available regarding their nursery technology. In the absence of a standard practice, direct sowing of seeds in the field results in erratic and inadequate germination. These factors contribute to high production cost of seedlings as well as

use of uneconomically high seed rate to raise adequate number of seedling stock.

Propagation of *Terminalia bellirica* and *Terminalia chebula* has always entailed a great deal of work and considerable expenditure of both money and time. The germination power of the seed is poor. The precise cause for this has not been ascertained. Tests at Dehra Dun with whole fruits as well as with nuts from which the outer fleshy covering was removed invariably gave poor results.

Collection of seeds at the proper time enhances the germination rate and plant per cent. With the use of the poor quality seeds, all the labour and money invested often goes waste. However, to achieve this aim it is necessary that we have well documented scientific information on nursery practices for the species. Hardly any information is available regarding sowing time, seed collection and presowing treatments.

Materials and Methods

The experiments were carried out in the nursery of the Dapartment of Silviculture and Agroforestry, Dr. Y.S. Parmar University of Horticulture and Forestry, Solan (H.P) during the years 1988 and 1989. The experimental area (altitude 1225 m above m.s.l.) is located at 30° 51' N latitude and 76° 11' E longitude. The area is well drained with silty loam soil.

Climatically, the area ranges from subtropical to sub-temperate with maximum temperature rising upto 34°C during summer. In winter months (December and January) the area experiences severe frost. The area receives an average 1100 m annual rainfall and the maximum precipitation occurs during monsoon season (July and August). The monthly averages of the weather data are given in Table 1.

The seeds were collected from fully matured fresh fruits obtained from matured trees in the months of December and January. The seeds were extracted from the fruit pulp and dried in shade before sowing. Extraneous material accompanying the seeds was rubbed off and removed.

The collected seeds of both the species were tested and 96% and 86% respectively of those of *Terminalia bellirica* and *Terminalia chebula* were found viable as described by Turnbull (1975).

The first experiment was laid out during March 1988 in split plot design with three replications. Collection was done on four dates - 10 December (C_1), 25 December (C_2), 9 January (C_3) and 24 January (C_4) and sowing on three dates - 1 March (S_1), 16 March (S_2) and 31 March (S_3). Seeds were sown at a distance of 20 x 20 cm.

Observations were recorded with regard to emergence of seedlings and their height and collar diameter. The final height and collar diameter of the seedlings were measured after 7 months with the help of metre scale and vernier calliper respectively. All the percentage values were worked out as recommended by Gomez and Gomez (1984).

The second experiment concerning the effect of presowing treatment on seed germination and growth of seedlings of *Terminalia bellirica* and *Terminalia chebula* was laid out in randomized block design with three replications in March 1988 were repeated in 1989 after giving different pretreatments to the seeds. The

Table 1

Meteorological data of the area (Nauni) during the year 1988 and 1989

Month	Temperature (°C)		Relative humidity (%)	Rainfall (mm)
	Maximum	Minimum		
1988				
March	21.4	4.1	52.1	115.6
April	30.5	13.3	43.7	20.0
May	33.7	15.0	42.2	119.8
June	32.7	17.5	54.6	90.6
July	28.9	20.2	81.9	1066.4
August	28.4	18.9	79.8	513.4
September	27.4	15.3	74.8	382.6
October	25.8	10.3	55.5	-
November	21.3	5.8	68.0	1.0
December	18.3	3.4	63.2	166.2
1989				
January	14.8	1.5	61.4	114.0
February	17.0	3.5	42.3	15.0
March	21.4	7.4	45.7	52.0
April	25.7	10.8	28.8	1.8
May	31.0	14.8	31.5	39.2
June	28.9	17.2	54.7	120.6
July	27.9	19.7	72.1	251.8

Source : Meteorological Observatory, Department of Forest Biology and Tree Improvement, UHF, Solan.

treatments for *T. bellirica* were : T_1 Control, T_2 mechanical scarification, T_3, T_2 + soaking in cold water for 24 h, T_4 dipping in conc. H_2SO_4 for 8 minutes., T_5 dipping in conc. H_2SO_4 for 10 minutes, T_6 dipping in conc. H_2SO_4 for 12 minutes, T_7 soaking in 100 ppm GA_3 for 24 h, and T_8 soaking in 200 ppm GA_3 for 24 h.

The treatments for *T. chebula* were : T_1 control, T_2 cowdung stratification for 8 weeks, T_3 cowdung stratification for 7 week, T_4 cowdung stratification for 6 weeks, T_5 cowdung stratification for 5 weeks, T_6 cowdung stratification for 4 weeks, T_7 cowdung stratification for 3 weeks, T_8 cowdung stratification for 2 weeks, T_9 cowdung stratification for 1 week, T_{10} dipping in conc. H_2SO_4 for 10 minutes and T_{11} dry heat treatment. (Before all stratification in treatments T_2 to T_9, the seeds were soaked in cold water for 24 h.).

For cold water treatments, the seeds were soaked in cold water for 24 and 48 h. In acid treatment, the seeds were pretreated with conc. H_2SO_4. The quantity of acid used for this treatment was almost twice the volume of seeds. Seeds were thoroughly washed in water for 2 h to make them acid free and then the excess moisture was removed by holding the seeds

between two pieces of filter paper before sowing. For cowdung stratification, the seeds were kept in a heap of cowdung for the prescribed period. Again, for GA_3 treatment, the seeds were soaked in GA_3 solution of different concentrations (100 and 200 ppm) for 24 h. In mechanical scarification, the dry seed coverings were gently cracked with the help of a hammer and then sown in beds. Fire is also a powerful natural factor for the removal of seed coat dormancy. In this treatment, a 40 to 45 cm deep pit was dug which was later filled with equally thick layers of sand, seeds and sand in that order. A controlled fire was burnt on the filled pits to facilitate the cracking of seed coat. The final observation was made after seven months.

Results and Discussion

(a) *Terminalia belliria*

1. *Dates of collection of seed and time of sowing* : It is evident from Table 1 that when the seeds collected in the second week of January were sown in the last week of March (C_3S_3), they took only 52 days to germinate and also gave 52.2 per cent seed germination (Fig.1). Dent (1948) reported that the fruits of *Terminalia bellirica* ripen from November to February and they are collected after they ripen. However, the number of days for germination is more and germination rate is low, because no presowing treatment was given to the seeds in this experiment.

The germination energy and survival rate were found to be non-significant, but satisfactory results were obtained in combination C_3S_3 (Date of collection 9 January and date of sowing 31 March) Fig. 1.

From the data on height of the seedlings, it is obvious that ideal time for seed collection is the first fortnight of January. Seeds collected during this period and sown on 16 March (S_2) and 31 March (S_3) gave seedlings of maximum height (17.4 and 18.4 cm respectively). This indicates that early seed germination contributes to greater height of the seedling.

Collar diameter of the seedling was not influenced by the date of collection. However, C_3S_3 combination gave seedling with maximum collar diameter of 0.81 cm.

2. *Effect of presowing treatments on seed germination and growth* : The experiments done in 1988 were repeated in 1989 after giving different pretreatments to the seeds. It is seen from Table 3 that seeds soaked in conc. H_2SO_4 for 12 min (T_6) took 37.7 days to germinate. With the same soaking treatment given for 10 min (T_5) the germination period was 42 days. Obviously, softening of seed coat by the soaking treatment results in early germination. Hartmann and Kester (1976) also reported a similar finding. With treatment T_6 (soaking in conc. H_2SO_4 for 12 min) the germination rate too was the highest (88%) (Fig.2). It follows that this treatment is superior to other treatments. It stimulates early and higher germination by breaking physical dormancy caused by the hard seed coat.

Comparison of data for 1988 and 1989 reveals that germination energy was highest (36.0%) in treatment T_6 (soaking of seeds in conc. H_2SO_4 for 12 min), closely followed by that (34.6%) in treatment T_4 (soaking in conc. H_2SO_4 for 8 min). The minimum value (24.0%) was obtained when no seed treatment was given. None of the treatments had any significant influence on percentage survival of the seedlings.

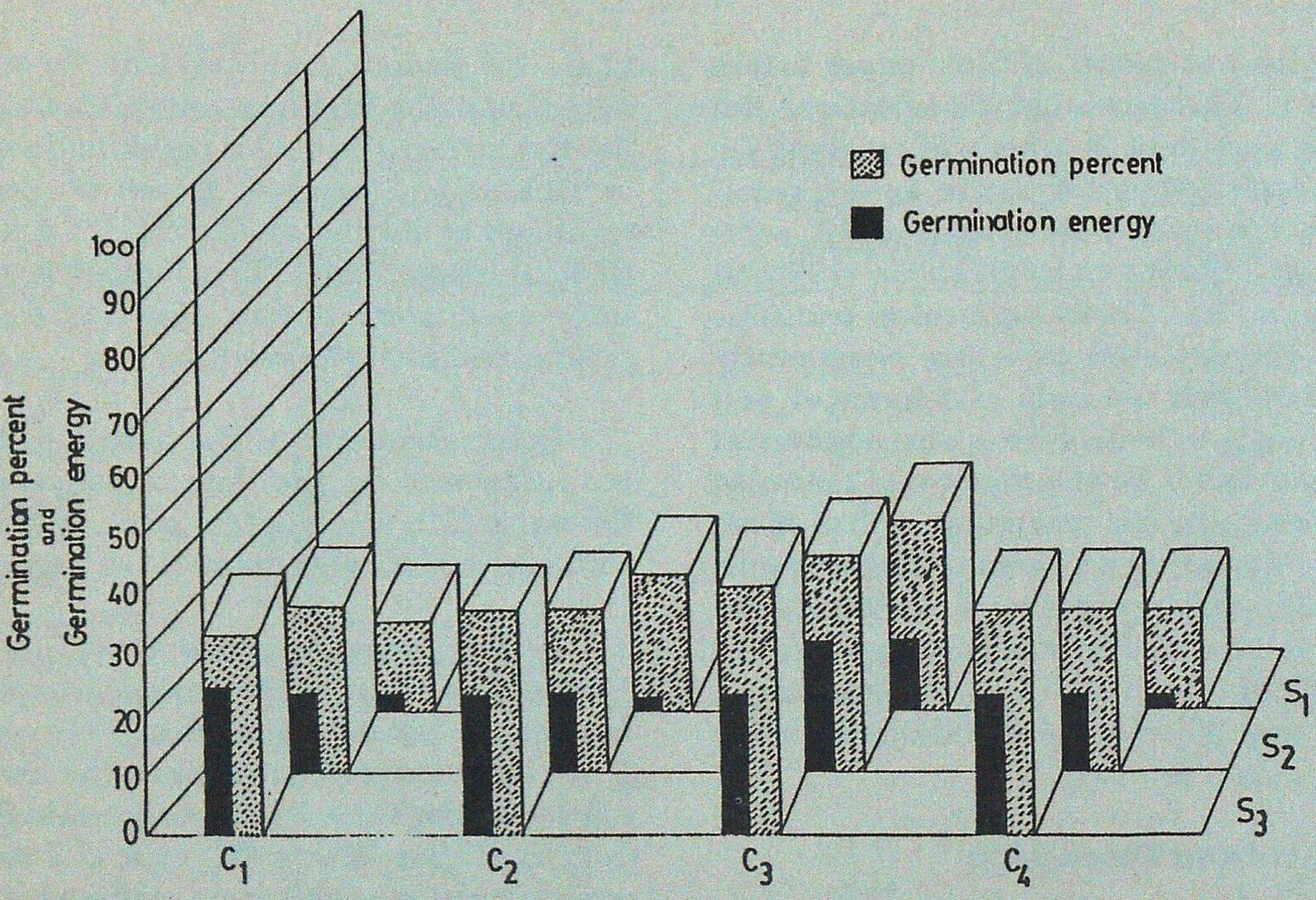

Fig. 1. Effects of dates of collection and sowing on germination Terminalia bellirica

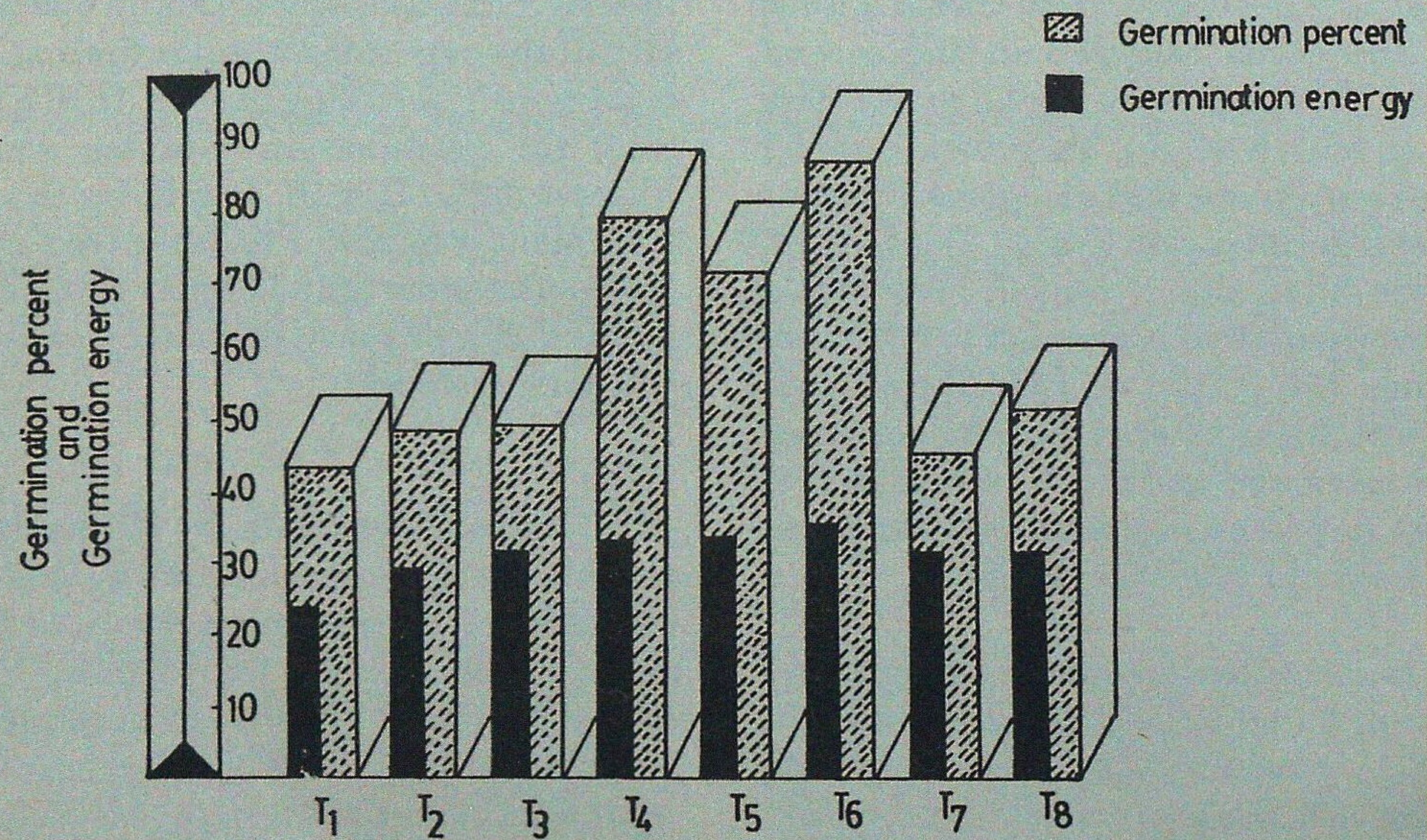

Fig. 2. Effects of presowing treatments on germination Terminalia bellirica

Table 2

Effect of date of collection and sowing time on time taken for germination and growth character of Terminalia bellirica and Terminalia chebula

Treatment	Germination (%)		Time taken for germination (days)		Plant height (cm)		Collar diameter (cm)	
	T. bellirica	*T. chebula*	*T. bellirica*	*T. chebula*	*T. bellirica*	*T. chebula*	*T. bellirica*	*T. chebula*
Date of collection of seed								
C_1 : 10 Dec. 87	35.9	36.9	68.9	151.1	14.8	14.0	0.69	0.46
C_2 : 25 Dec. 87	39.6	36.6	58.7	148.4	16.3	13.8	0.68	0.46
C_3 : 9 Jan. 88	46.6	41.1	57.3	148.4	17.3	13.1	0.74	0.47
C_4 : 24 Jan. 88	37.7	33.6	56.3	150.6	16.5	12.9	0.69	0.42
S. Em ±	0.9	1.3	0.8	0.9	0.5	0.3	0.05	0.004
C.D. 5%	1.9	3.7	1.6	NS	1.1	0.6	NS	0.01
Date of sowing								
S_1 : 1 March, 88	37.4	33.8	63.7	156.5	15.7	13.4	0.65	0.42
S_2 : 16 March, 88	35.2	42.4	57.6	142.2	16.4	14.6	0.71	0.49
S_3 : 31 March, 88	42.2	34.9	60.0	152.1	16.5	12.4	0.73	0.45
S. Em±	5.7	1.2	0.8	1.8	0.7	0.4	0.07	0.01
C.D. 5%	3.5	3.5	2.2	5.0	NS	1.3	NS	0.02

Table 3

Effect of presowing treatments on germination and growth of seedlings of T. bellirica

Treatments	Time taken for germination (days)	Germination per cent	Germination energy	Growth character: Height (cm)	Growth character: Collar dia. (cm)
T_1	63.0	44.0 (51.5)	24.0 (29.2)	8.3	0.46
T_2	53.0	49.3 (44.6)	29.3 (32.7)	9.5	0.62
T_3	50.0	50.6 (43.8)	32.0 (34.4)	9.3	0.60
T_4	42.7	80.0 (63.5)	33.3 (35.2)	10.3	0.62
T_5	42.0	72.0 (51.9)	34.6 (36.0)	10.3	0.59
T_6	37.7	88.0 (69.0)	36.0 (36.8)	11.7	0.64
T_7	61.7	46.6 (43.0)	32.0 (34.4)	8.7	0.62
T_8	60.0	52.0 (46.1)	32.0 (34.2)	9.0	0.58
S.Em ±	1.9	2.9	1.8	0.2	0.02
C.D. 5%	4.1	6.3	3.8	0.4	0.04

Regarding growth behavior of the seedlings the values for height and collar diameter measured in November 1988 were found to be significantly higher in the case of seedling grown from seeds given treatment T_5 (10 min soaking in conc. H_2SO_4). In the 1989 experiment the plant height and collar diameter were significantly higher with treatment T_6 (12 min soaking in conc. H_2SO_4). Obviously, the seed which commences germinating earlier gives seedlings which attain greater height in comparison to those germinating later.

(b) *Terminalia chebula*

1. *Dates of collection of seed and time of sowing* : The data given in Table 2 reveal that the seed collected in the second week of January (C_3) and sowed in the third week of March (S_2) took less time to germinate. The same combination (C_3S_2) gave 44.4 per cent germination (Fig. 3). However, the time taken to germinate as well as the percentage germination are low because no presowing treatment was given to the seeds in this experiment.

Singh (1915) reported that there is some correlation between the maximum tannin content in the fruit of *Terminalia chebula* and the optimum germination capacity. Therefore, the time of collection is important. Prasad (1946) reported that the first fortnight of January is the best period for collecting seeds of *Terminalia chebula* in Punjab.

Germination energy and percentage survival bear no significant correlation with the dates of collection of seeds and sowing and any of their combinations (Fig 3).

The data given in Table 2 indicate that seeds collected on 25 December and 9 January (C_2 and C_3) and sowed on 16 March (S_2) gave seedlings with maximum height and collar diameter. The probable reason for this is that the seeds took minimum time to germinate, resulting in higher germination rate and plant growth.

2. *Effect of presowing treatments on seed germination and growth* : It is seen from Table 4 that time taken for germination of

Table 4

Effect of presowing treatments on germination and growth of seedlings of T. chebula

Treatments	Time taken for germination (days)	Germination per cent	Germination energy	Growth character: Height (cm)	Growth character: Collar dia. (cm)
T_1	150.0	28.0 (31.9)	25.3 (30.2)	17.62	0.64
T_2	126.0	60.6 (50.4)	24.0 (29.2)	18.73	0.65
T_3	117.3	61.3 (51.6)	28.0 (31.9)	21.87	0.64
T_4	115.3	56.0 (48.4)	33.3 (35.1)	22.95	0.70
T_5	107.3	77.3 (61.5)	35.0 (36.0)	21.80	0.66
T_6	111.6	62.6 (52.4)	32.0 (34.4)	19.87	0.66
T_7	114.3	52.0 (46.1)	28.0 (31.9)	20.07	0.68
T_8	125.0	44.0 (41.5)	26.6 (31.0)	16.33	0.66
T_9	142.3	36.0 (36.8)	26.6 (31.0)	18.07	0.68
T_{10}	135.6	36.6 (33.6)	25.3 (30.2)	8.47	0.59
T_{11}	130.6	24.0 (29.2)	24.0 (29.2)	20.98	0.75
S.Em ±	2.9	3.1	1.7	6.48	0.25
C.D. 5%	6.2	6.6	3.6	13.47	NS

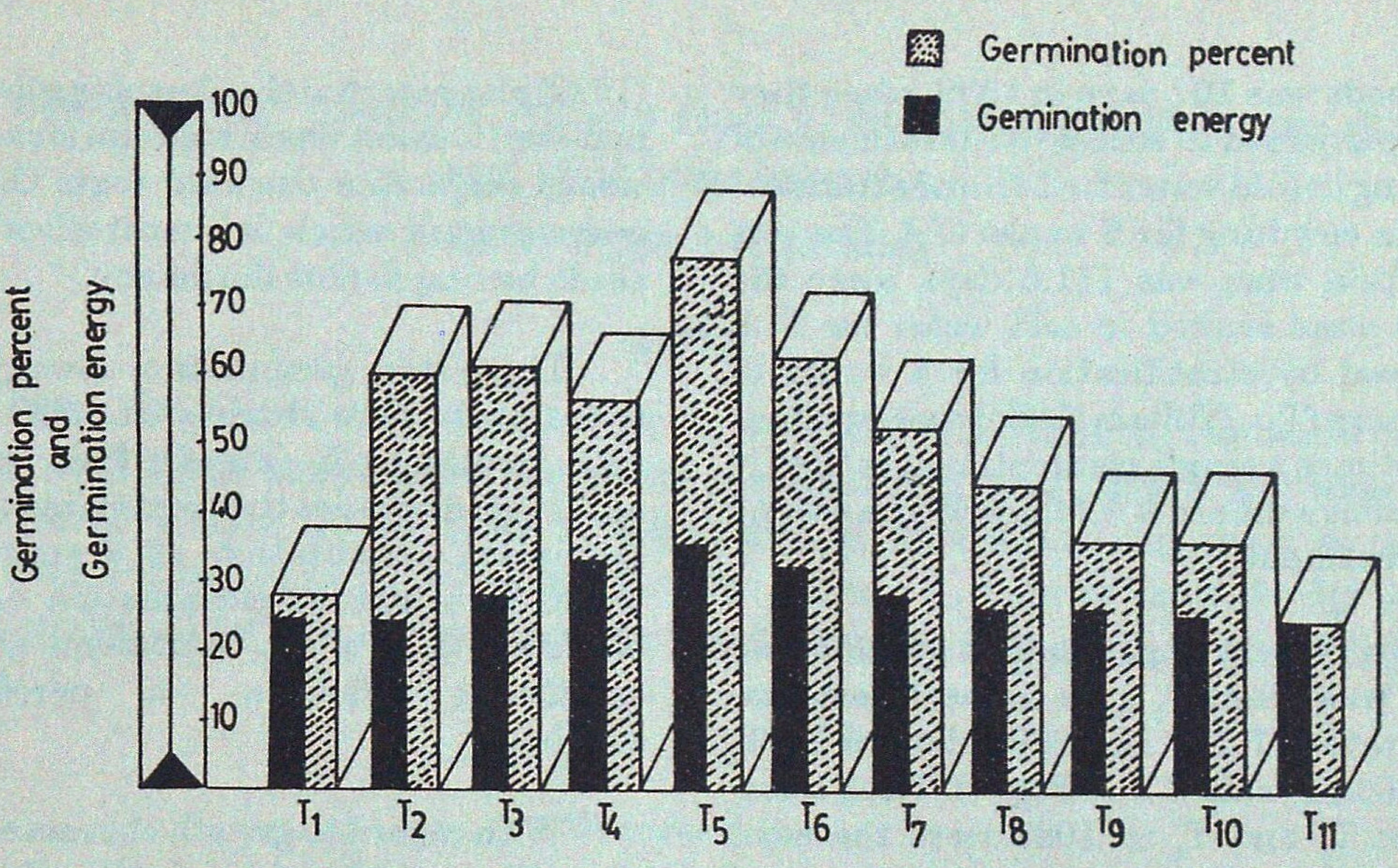

Fig. 3. Effects of pre sowing treatments on germination in Teminalia chebula

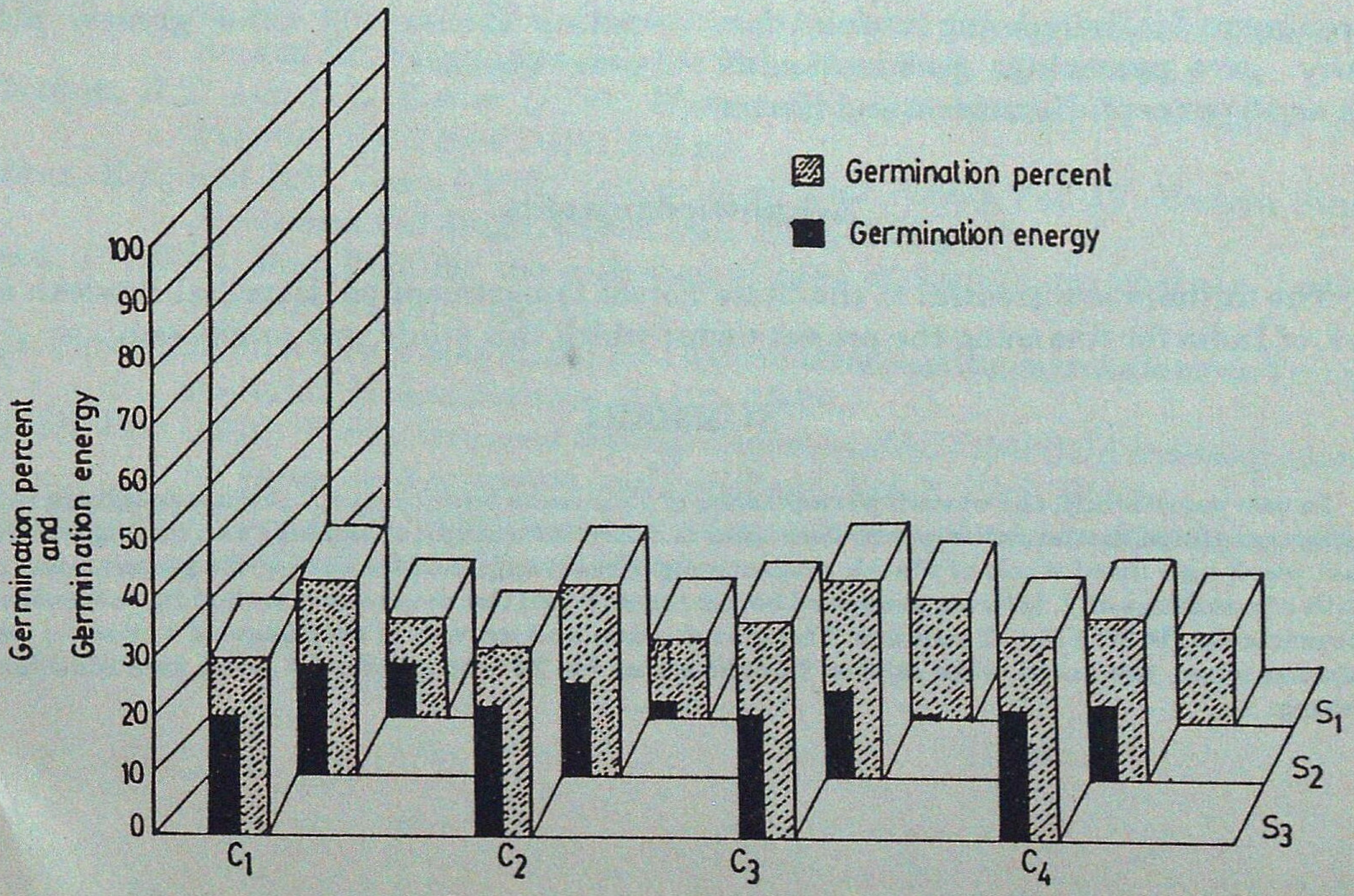

Fig. 4. Effects of dates of collection and sowing germination in Terminalia chebula

the seeds was 107 days in 1989, when they were subjected to successive treatments of soaking in cold water for 24 h and stratification in cowdung for 5 weeks (T_5). The germination time was 111.6 days when the seeds were soaked in cold water for 24 h followed by stratification for 4 weeks in cowdung (T_6). William (1985) observed that sometimes a single pretreatment is largely ineffective unless it is followed by a second pretreatment.

In respect of percentage germination also, treatment T_5 gave highest germination rate (77.3%) in 1989 followed by T_6 (62.66%) (Table 4 and Fig. 4). Thus treatments T_5 and T_6 in 1989 were the most suitable ones for breaking the dormancy of *Terminalia chebula* seeds. Bonner (1978), working on *Cercis candersis*, found that single treatment gave less than 10 per cent germination, while successive application of treatment for overcoming internal dormancy gave percentage germination as high as 65 per cent. Hartmann and Kaster (1976) also reported that keeping seeds in a non-sterile moist warm medium for several weeks can soften the seed coats through micro-organic action. It is most effective for seeds having double dormancy.

Regarding germination energy, the best results were obtained in 1989 (35%) with treatment T_5 (Fig 4). This is to be anticipated because the treatment causing maximum stimulation of germination would give highest germination energy. However, none of the treatments showed significant influence on percentage survival.

With regard to growth characteristics of seedlings, the height and collar diameter were found to be significantly better under treatment T_5 in 1988. The same observation was made in the 1989 experiments. Obviously, a seed which commences germinating earlier will show greater plant growth sooner.

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SUMMARY

In two years study, the overall performance of *Terminalia bellirica* and *T. chebula* seedlings in the nursery were found better, when seeds were collected in first fortnight of January and sowing was done at last week and third week of March respectively. Presowing seed treatment on germination and growth of seedlings of *T. bellirica* produced better result when the seeds were soaked in concentrated sulphuric acid (H_2SO_4) for 12 minutes. The germination and growth of seedlings of *T. chebula* were maximum when the seeds were soaked in cold water for 24 hours before 5 week stratification in cowdung.

टर्मिनेलिया बेलेरिका राक्स० और *टर्मिनेलिया चिबुला* रेटज० के बीज संग्रह, बोने के समय और बुवाई पूर्व बीजोप्चार का अध्ययन

बी० डी० भारद्वाज व ए० के० चक्रवर्ती

सारांश

दो वर्ष तक किए अध्ययन में *टर्मिनेलिया बेलेरिका* और *ट० चिबुला* की समग्र क्रियाशीलता उस समय श्रेष्ठतर पाई जब उनका बीज जनवरी के प्रथम पखवाड़े में इकट्ठा किया गया और उसकी बुआई क्रमशः मार्च के अन्तिम व तीसरे सप्ताह में की गई। *ट० बेलेरिका* के अंकुरण और पौधों की वृद्धि पर बीजों का बुआई-पूर्व उपचार करने का प्रभाव श्रेष्ठतर तब रहा जब बीजों को गन्धक के तेजाब (एच$_2$एस ओ$_4$) में 12 मिनट तक डुबोकर रखा गया। *ट० चिबुला* का अंकुरण और पौधों की वृद्धि उस समय अधिकतम रही जब उसके बीजों को 5 सप्ताह तक गोबर में स्तरित करने से पूर्व 24 घंटे तक ठंडे पानी में डुबोकर रखा गया।

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EARLY EVALUATION OF *POPULUS DELTODIES* CLONES IN JAMMU-TAWI

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Introduction

Poplars are amongst the world's fastest growing industrial softwood and are greatly valued for their multiple utility. Poplar wood is in much demand in match and packaging industries besides being a useful source of light constructional material. The wood is also used in paper and pulp, plywood, fibre boards and in Veneer industries. Six species of poplars are indigenous to the Northwestern Himalayas but on account of their limited and scattered distribution, none of the indigenous species could gain any commercial success (Mathur and Sharma, 1983). However, some exotic poplar species like *Populus nigra, P. yunnanensis* and *P. robusta* gave encouraging results in the foot hills of Northern India while in the plains, above 27° north latitude, the exotic clones of *P. deltoides* viz., G-3, G-48, D-67, D-100 and D-121 were found to be more suitable (Sharma *et al.*, 1991). *P. deltoides* clones, G-3, G-48 and D-121 were also found to be successful in the marginal (usar) soils of Uttar Pradesh (Anon, 1988). The criteria for assessing the suitability of various clones, in different areas were mainly based on survival, height and breast height diameter growth of the trees but the nature and development of the root systems in these clones were not studied. As the form of the root system, the depth of its penetration into the soil, the number of its branches and their spread markedly affect the absorption of nutrients and also provide a mechanical device for supporting the shoot system in the soil substrate, it is, therefore, necessary that along with the shoot systems, the nature and development of the roots are also studied. With this in view, a field trial with three *P. deltoides* clones, G-3, G-48 and D-121 was planned in the subtropical climate of Jammu.

Materials and Method

The field trial was conducted at the Field Station of the Regional Research Laboratory, Jammu-Tawi, situated at Chatha, at a distance of 12 km from Jammu Tawi. The area lies between 32° 30' N latitude, 74° 75' E longitude at an elevation of 280 m above msl. It experiences great extremes of temperature. June is the hottest month with average maximum temperature 38.9°C and average minimum temperature 26.9°C. January is the coldest month with average maximum temperature 19.4°C and average minimum temperature 6.8°C. Proper monsoon sets in sometimes in the first weak of July and continues till September. Annual rainfall is 1133 mm, of this nearly 70% is received during the monsoon months. The soil at the Field Station is sandy loam and poor in organic matter as well as available

nutrients (organic carbon 0.32%; available P_2O_5 15.0 kg/ha; available K_2O 118.0 kg/ha). Soil pH is 7.8.

The field trial was laid on 14th January, 1990, in a replicated randomised block design with the three *Populus deltoides* clones, G-3, G-48 and D-121, procured from the National Botanical Research Institute, Lucknow. Initially, each treatment comprised of 100 cuttings, planted in plots of 10 m x 10 m, at a spacing of 1 m x 1 m. However, after 12-month's growth, saplings from the alternate rows were removed, leaving only 25 plants per plot, at a spacing of 2 m x 2 m. Each treatment was replicated seven times. Immediately after transplanting the cuttings, the field was flood irrigated. A second irrigation was given after seven days. Thereafter the field was not irrigated till the end of March, as it continued to rain quite frequently. However, during the hot summer months of April to June and again during the drier months of October to December, the field was irrigated at fortnightly intervals during the first year only. The trial was conducted without the application of manure or fertilizer. Cuttings started sprouting with the warming up of the temperature in mid-February and by mid-March majority of the cuttings had sprouted.

First observation on height and number of shoots per sapling was recorded after 3½ months sprouting of the cuttings of all the 100 plants in each plot. Second observation on height, collar and breast height diameter of the stems as well as of the number of branches per plant was recorded after 12 months' growth of the 16 innermost plants in each plot. But the third observation on the growth of the stems was taken on the innermost 9 plants in each plot after 24 months' growth. However, for determining the dry weight of stem, root and whole plant and also for studying the underground root systems, 3 plants were randomly dug out from each plot at 12 and 24-months age and the number and total length of all first order lateral roots in each plant were recorded. The plants were then separated into shoot and root portions, dried at 80°C and weighed. All observed data at 12- and 24-months' age were analysed for statistical significance.

Results

Growth at 3½ months' age : At 3½ months' age, mean sapling height was highest in G-3 and G-48 but lowest in D-121 (Table 1). Mean number of shoots per sapling was also highest in G-3. However, the Cv values for sapling height and the number of shoots per sapling were low in D-121 but high in G-3 and G-48.

Growth and biomass at 12-months' age : At 12-months' age, mean height and breast height diameter of the stems as well as the number of branches per plant were maximum in G-3, medium in G-48 and minimum in D-121. Statistically, differences between G-3 and D-121 in height and number of branches per plant were significant. However, the number and the total length of all first order lateral roots per plant were maximum in D-121, medium in G-48 and minimum in G-3. Statistically, difference between D-121 and G-3 in respect of number of lateral branches was also significant. On the other hand, the dry weight of stem and whole plant were maximum in G-48, medium in G-3 and minimum in D-121. The dry weight of root was also maximum in G-48 but medium in D-121 and minimum in G-3. However, the root : shoot ratio was lowest in D-121, moderate in G-48 and highest in G-3.

Table 1

Growth and biomass of Populus deltoides clones at 3½, 12- and 24-months' age

Growth at 3½ months' age

Clones	Sapling height (m)				No. of shoots/sapling			
	Range	Mean	Sd.	Cv.	Range	Mean	Sd.	Cv.
G-3	0.17-1.52	0.76	0.24	32.50	1-5	2.20	0.92	43.29
G-48	0.07-1.66	0.77	0.25	35.92	1-5	1.74	0.69	39.99
D-121	0.13-1.23	0.60	0.18	30.39	1-4	2.05	0.79	38.50

Growth and biomass at 12- months' age

Clones	Ht. (m)	Cd. (cm)	Dbh. (cm)	Branch (No.)	No. of first order lateral roots/sapling	Total length (m) of all first order lateral roots/sampling	Dry weight (gm) of			Root : Shoot ratio
							Stem	Root	Whole plant	
G-3	4.10	3.28	2.08	10.00	8.42	5.61	591.42	146.57	738.14	1:4.03
G-48	3.61	3.42	2.02	9.54	11.14	8.13	647.57	213.85	861.71	1:3.02
D-121	3.61	3.35	2.00	2.41	13.85	8.82	429.85	210.09	639.85	1:2.04
C.D. at 5%	0.06	N.S.	N.S.	2.77	3.01	6.27	189.31	43.36	N.S.	

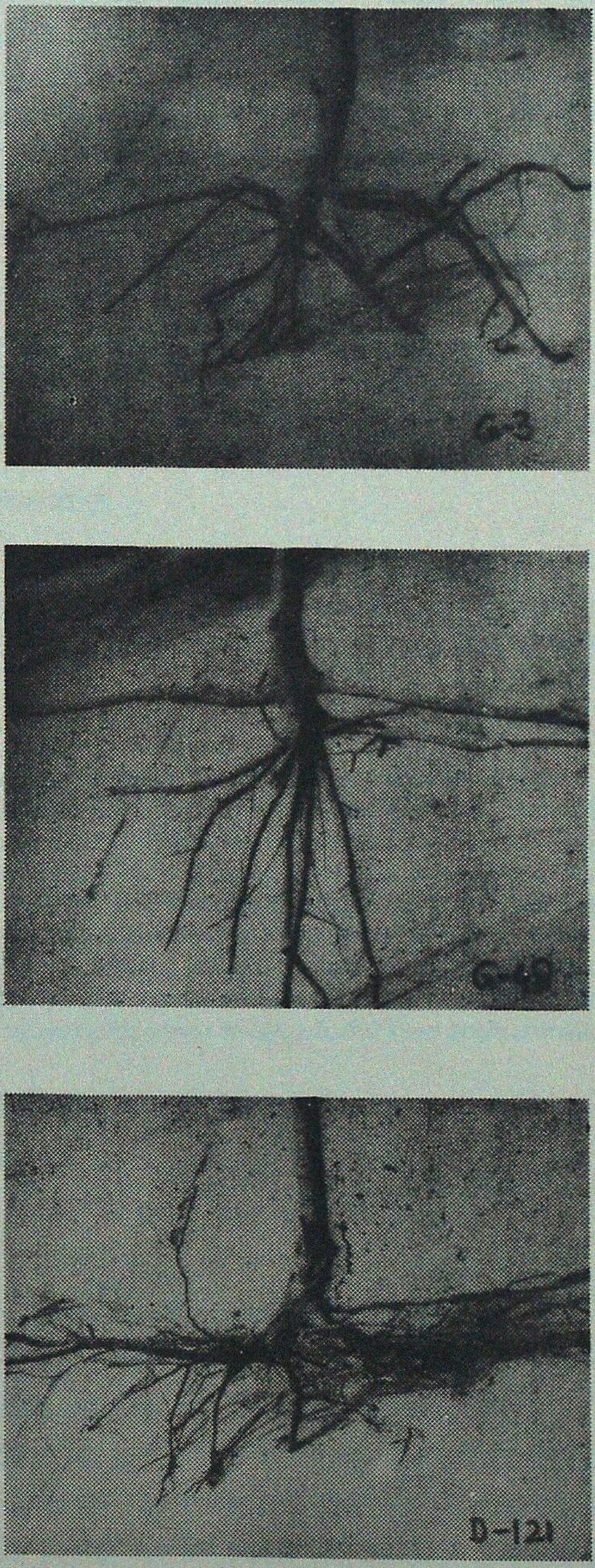
Growth and biomass at 24-months' age

Clones	Ht. (m)	Cd. (cm)	Dbh. (cm)	Branch (No.)	No. of first order lateral roots/sapling	Total length (m) of all first order lateral roots/sampling	Dry weight (gm) of			Root : Shoot ratio
							Stem	Root	Whole plant	
G-3	6.40	5.63	4.01	28.28	10.71	8.89	2.759	0.797	3.557	1:3.46
G-48	6.07	5.94	3.86	32.02	12.14	11.74	2.901	1.036	3.937	1:2.80
D-121	5.70	5.87	3.63	26.10	15.14	14.08	2.169	0.933	3.103	1:2.32
C.D. at 5%	0.38	N.S.	N.S.	1.78	1.91	2.58	0.279	0.155	0.248	

N.S. : Not Significant

Growth and biomass at 24 months' age : At 24 months' age, G-3 attained maximum height and breast height diameter growth but the collar diameter and the number of branches per plant were maximum in G-48. All these growth parameters were at their minimum in D-121. However, the number and total length of all first order lateral roots per plant were maximum in D-121, medium in G-48 and minimum in G-3 (Fig. 1). On the other hand, dry weight of stem and whole plant were maximum in G-48, medium in G-3 and minimum in D-121 and the differences were statistically significant over D-121. The dry weight of root was also maximum in G-48 but medium in D-121 and minimum in G-3. However, the root : shoot ratio was lowest in D-121, moderate in G-48 and highest in G-3.

Fig. 1



Representative root samples of *Populus deltoides* clones G-3, G-48 and D-121 at 24-months' age

Discussion

G-3 excelled G-48 and D-121 in height and breast height diameter at 12- and 24-months' age but the number and total length of all first order lateral roots as well as the dry weight of root in G-3 were quite low and the root : shoot ratio was quite high. The spread and penetration of first order lateral roots in the soil was also minimal in G-3. G-3 was also found to be less resistant to wind throw. Within the very first year, 2.26% of G-3 plants were uprooted by high winds; against 2.00% in G-48 and only 1.15% in D-121. G-3 may not, therefore, be a likely clone suitable for the agroclimatic conditions of Jammu.

On the other hand, height and breast height diameter growth as well as the dry weight of stem and whole plant were minimum in D-121. But the number and total length of all first order lateral roots were maximum in D-121. The spread of the

lateral roots were also maximum in D-121 and the finer roots were extensively developed in this clone. The root : shoot ratio was also lowest. However, the slower growth rate of the shoots and the overall low productivity of D-121 are the two major constraints for selecting this as a suitable clone for the agroclimatic conditions of Jammu.

Height and breast height diameter growth in G-48 were next best only to G-3, the collar diameter growth was also maximum in G-48. The overall root development was excellent in G-48 with all the lateral roots penetrating much more deep in the soil and were much more robust than G-3 and D-121. The number and total length of all first order lateral roots were moderately high and were next best only to D-121. Over and above these, the dry weight of stem, root and whole plant were maximum in G-48 and the root : shoot ratio was also quite satisfactory. G-48 thus appears to be much more suitable for the agroclimatic conditions of Jammu.

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SUMMARY

Early growth and biomass of three *Populus deltoides* clones, G-3, G-48 and D-12, were evaluated in a field trial in the subtropical climate of Jammu (latitude 32° 30' N longitude 74° 55' E; altitude 280 m above msl). Height and breast height diameter growth at 12- and 24-month's age were maximum in G-3 but the number and total length of all first order lateral roots were minimum in G-3. On the other hand, height and breast height diameter growth were minimum in D-121 but the number and total length of all first order lateral roots were maximum in D-121. The root : shoot ratio was maximum in G-s but minimum in D-121. Height breast height diameter growth as well as the number and total length of all first order lateral roots and the root : shoot ratio were intermediate in G-48. However, the dry weight of shoot, root and whole plant were maximum in G-48 both at 12- and 24-months age.

जम्मू-तवी में *पापुलस डेल्टायडिस* कृन्तकों का पूर्व मूल्यांकन

ए0 के0 दत व उर्मिला जमवाल

सारांश

पापुलस डल्टायडिस के तीन कृन्तको, जी-3, जी-48 व डी-12। की पूर्व वृद्धि और जैवपुंज का मूल्यांकन जम्मू (अक्षाशं 32^0 30', देशान्तर 74^0 55', उंचाई माघ्य समुद्र तल से 280 मी0 की उपोषण जलवायु में किए गए क्षेत्र परीचक्षण में किया गया। 12 और 24 महीने बाद ऊंचाई और वक्षोच्चता व्यास में अधिकतम वृद्धि जी-3 में पाई गई परन्तु प्राथमिक पार्श्व जडों की संख्या और उनकी कुल लम्बाई जी-3 में न्यूनतम थी। इसके विपरीत ऊंचाई और वक्षोच्चता व्यास डी-121 में न्यूनतम थे परन्तु प्राथमिक पार्श्व जडों की संख्या और उनकी कुल लम्बाई डी-121 में अधिकतम थी। ऊंचाई, वक्षोच्चता व्यास और प्राथमिक पार्श्व जडों की संख्या व उनकी कुल लम्बाई एवं जड व प्ररोह का अनुपात सभी जी-48 में अन्तरवर्ती रहे। तथापि, प्ररोह, जडों और पूरे पौधों का भार 12 महीने बाद और 24 महीने बाद दोनों में जी-48 में अधिकतम पाया गया।

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FUNGI ASSOCIATED WITH THE DECOMPOSITION OF TEAK AND *ALBIZIA* LEAF LITTER IN KERALA

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Introduction

Litter decomposition is an important process of the nutrient cycling in forest ecosystems (Charley and Richards, 1983). The amount and nature of litter which is the major source of a variety of organic matter, has an important bearing on soil formation and its fertility.

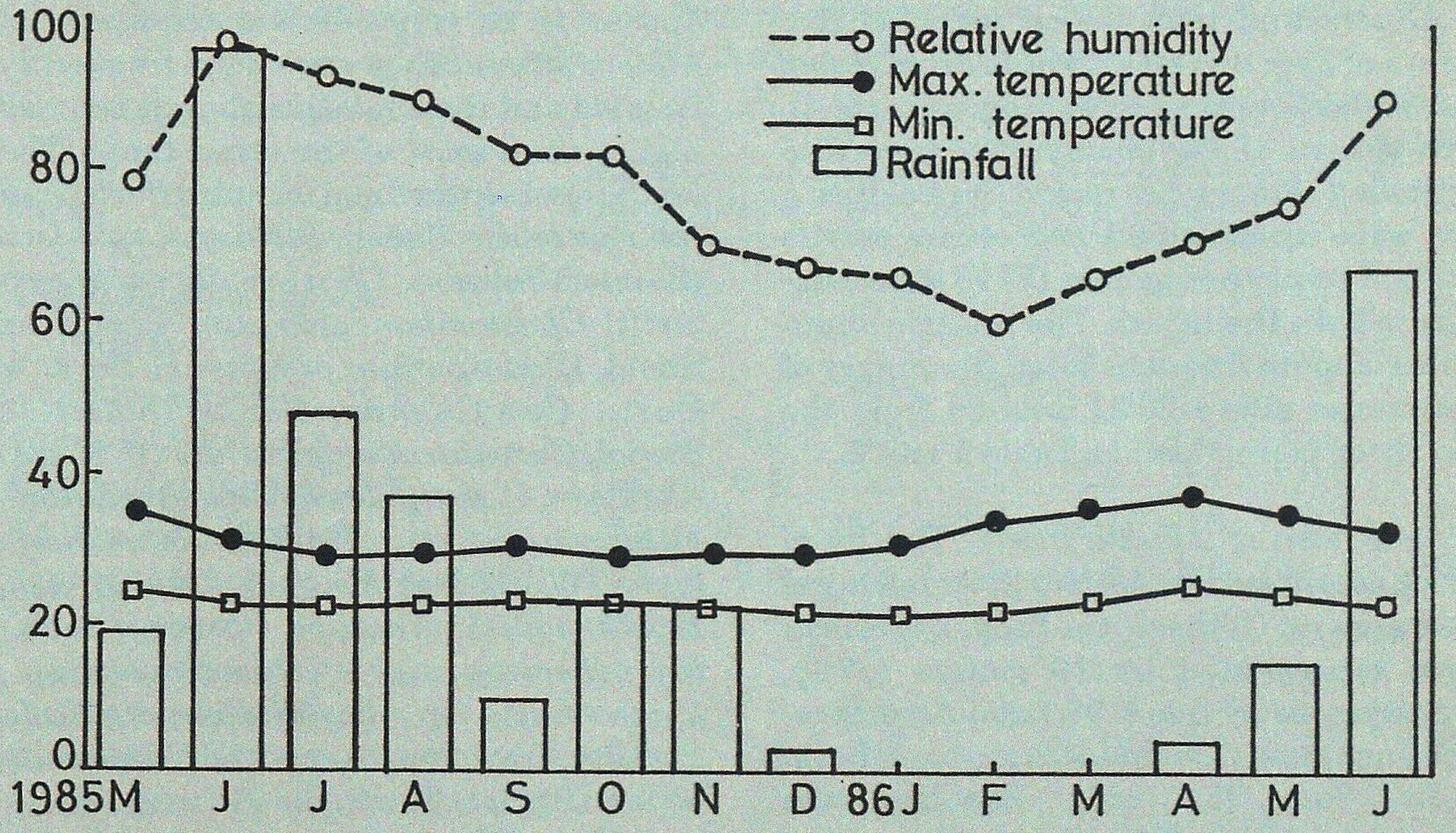
It is now well established that the decomposition of plant litter on the soil surface is brought about by a variety of micro-organisms including bacteria, fungi and actinomycetes (Jensen, 1974; Swift *et al.*, 1979). Among these, fungi are the chief colonizers and decomposers (Dickinson and Pugh, 1974). There is a dearth of information on the fungi associated with decomposition of litters of indigenous as well as exotic tree species grown in plantations in India. This paper reports the succession of fungi on decomposing leaf litters of teak (*Tectona grandis* L.) and *Albizia falcataria* (L.) Fosberg, which are commonly raised in plantations in Southern India.

Materials and Methods

Study area : The study area was located in the campus of Kerala Forest Research Institute (KFRI) at Peechi (10° 32' N latitude and 76° 32' E longitude). The area had a tropical warm humid climate and a typical moist deciduous forest vegetation. The most common species of the campus are *Tectona grandis* L., *Xylia xylocarpa* (Roxb.) Taub., *Terminalia paniculata* Roth, *T. crenulata* Roth, *T. bellirica* (Gaertn.) Roxb., *Bombax ceiba* L. and *Bridelia retusa* (L.) Spreng. Mean Annual rainfall was approximately 3000 mm. Mean atmospheric temperature varied from a monthly maximum of 29°C in July to 38°C in April and mean monthly minimum of 21.9°C in January and 25.9°C in April. Three seasons are recognised, summer (January to mid May), South-West (SW) monsoon (mid May to August) and North-East (NE) monsoon (September to December). The average relative humidity range between 60% in February and 96% in June. The climatic data for Peechi are shown in Fig 1.

Litter decomposition : Freshly fallen leaves were collected during March 1985 from the plantations of *Albizia* (10-yr-old) and teak (25-yr-old) located respectively at Vazhachal and Vallikayam in Trichur Forest Division, Kerala State. The leaves were air dried to constant moisture content. In April 1985, 20 g of the air dried leaf litter of each of the two species was transferred separately into nylon mesh bags (20 x 20 cm; mesh size 2 mm) and the openings closed firmly by stitching.

Fig. 1



Field studies on litter decomposition were conducted in two 6 m x 1.5 m plots situated at the same site in the KFRI campus. Approximately 300 kg of soil collected from the plantations of teak and *Albizia* was spread evenly in the selected plots separately. Sixty litter bags, prepared for each of the two species were spread randomly (in CRD) over the soil surface in separate plots allotted to each species in April 1985.

Sampling of litter bags was initiated in May 1985 which continued at monthly intervals, till October 1985; thereafter samples were collected during the months of December 1985 and June 1986 only. Three litter bags of each species were recovered at each sampling. The dilution plate technique (Parkinson *et al.*, 1971) was employed to isolate fungi from the decomposing litter. The litter was cleaned free of extraneous materials (using a sterile brush), air-dried, powdered in an ice-cooled blender and 10 g suspended separately in 100 ml sterile water in 250 ml conical flasks. The suspension was diluted to 10^{-3} and 1 ml each transferred separately to five replicate Petri dishes. Potato Dextrose Agar (PDA) and Martin's rose Bengal agar were the media used for isolation. The Petri dishes were incubated at 30 ± 2°C in an incubator for 7 days and then transferred to room temperature. The developing fungal colonies were transferred to PDA slants for pure growth and sporulation which facilitate identification. The plates were observed for a period of 15 days and the colonies of fungi enumerated and identified. The relative abundance (%) of each taxon was calculated using the following formula: relative abundance = number of isolates of a species/total number of isolates x 100.

Results

A total of 37 genera of fungi were

isolated from the decomposing leaf litters of *Albizia* and teak which included five gerera of Zygomycetes, two of Ascomycetes and 30 (81%) belonging to fungi imperfecti. Two genera of Basidiomycetes were also identified. Among the rest of the isolates, a few were unidentified and others sterile forms. Twenty one genera (57%) were common to both the litters. The relative abundance of more frequent fungi (frequency of occurrence above 20%) isolated from the leaf litter is provided in Table 1 and 2.

Fungal flora of Albizia litter : The fungi which colonised the *Albizia* litter belonged to 26 genera. Of these, the fungi imperfecti were represented by 20 genera (77%), Zygomycetes by five (19%) and Ascomycetes by one genus. *Collybia leucophaea* (Berk. & Br.) Sacc., the only Basidiomycete observed, produced fruiting bodies on the litter only during July and October 1985 (Table 1).

The dominant primary saprophytes of the litter were Penicillia, Aspergilli, *Doliomyces mysorenis, Robillarda sessilis* and *Trichoderma viride. Aspergillus niger*, which harboured the litter throughout the sampling period, except the freshly fallen litter, was the most frequent and dominant fungus. The relative abundance of *A. niger* was highest during SW monsoon (June-September). On the other hand *Pencillium* spp. were dominant on the freshly fallen litter and their population decreased during the course of decomposition.

Aspergillus spp., *Doliomyces mysorensis, Fusarium* spp, *Robillarda* spp. and *Trichoderma viride* were the most frequent and dominant secondary colonizers of *Albizia* litter. Although *Curvularia lunata* was also isolated frequently from the litter, its relative abundance was low. *Doliomyces mysorensis* and *Robillarda* spp. appear to be very efficient colonizers of *Albizia* litter as they were more frequently isolated and their relative abundance was higher than most of the other fungi. The less frequent litter fungi included *Bartalinia robillardoides* Tassi, *Bipolaris spicifera* (Bainier) Subram., *Chaetomella raphigera* Swift, *Chaetomium globosum* Kunze ex Steud, *Cladosporium oxysporum* Berk. & Curt., *Cunninghamella bertholletiae* Stadel, *Curvularia eragrostidis* (P. Henn) JA Meyer, *C. senegalensis* (Speg.) Subram., *Fusarium oxysporum* Schlecht., *Monodictys levis* (Wiltshire) Hughes, *Mucor* sp., *Myrothecium cinctum* (Corda) Sacc., *Myrothecium* sp., *Pestalotiopsis* sp., *Pyrenochaeta* sp., *Scytalidium lignicola* Pesante, *Trichoderma* spp. and *Ulocladium atrum* (Preuss) Sacc.

Fungal flora of Teak litter : Thirty-two genera of fungi were isolated from the decomposing teak litter. Of these, fungi imperfecti were represented by 28 genera (87.5%) Zygomycetes by three (9.4 %) and Ascomycetes by one genus. *Marasmius* sp., the only Basidiomycete observed, colonized the litter during October 1985 (Table 2).

Aspergilli, Penicillia, *Coniella, Tritirachium* and sterile forms were the dominant primary saprophytes of the litter. The most frequent and dominant colonizers of the litter during the entire period of study were species of *Aspergillus, Penicillium* and *Phoma*. Among the secondary saprophytic fungi, *Aspergillus niger, Aspergillus* spp., *Curvularia lunata, Fusarium* spp., Penicillia, *Phoma* spp., *Robillarda* sp., *Trichoderma viride, Ulocladium atrum* and the sterile forms occurred in comparatively higher frequency and dominance than other fungi. The less

Table 1

Relative abundance (%) of more frequent fungi isolated from the leaf litter of Albizia falcataria during different months

Fungi	ff*	1985							1986
		May	June	July	Aug.	Sep.	Oct.	Dec.	June
Absidia cylindrospora Hagem	0.5							0.1	
Acremonium sp.				0.4	0.8				
Alternaria sp.			0.6	2.2					
Aspergillus flavus Link		1.0	0.4	0.9	1.6	3.6	0.7	0.3	
A.niger Van Tieghem		6.4	51.5	29.4	35.5	19.4	4.8	1.8	28.7
Aspergillus spp.	1.5	16.2	8.8	2.2		0.8	13.3	37.3	25.0
Cladosporium cladosporioides (Fresens)de Vries		0.3		2.6					
C. lunata (Wakker) Boedijin		0.1	1.4	0.4		0.6	0.1	0.1	0.8
Doliomyces mysorensis Nagraj & Kendrick	7.9	56.1		23.4			20.8		0.4
Fusarium solani (Mart.) Sacc.	0.7					12.5	1.3		
Fusarium spp.		5.4	0.4	7.8	22.0		0.7	2.5	16.2
Penicillium spp.	61.4	6.1	14.1		0.8	1.1		0.1	2.3
Phoma sp.							0.1		0.4
Rhizopus oryzae Went & Geerligs						1.9		0.1	
Rhizopus sp.		0.2							0.4
Robillarda sessils (Sacc.) Sacc.	10.7					35.9			
Robillarda sp.		7.4	17.3	19.0			57.4		1.0
Syncephalastrum racemosum Cohn ex Schrot.	0.2		1.0						
Trichoderma viride Pers., ex Gray	0.5	0.5	2.8	6.5	21.6	9.7			0.2
Unidentified fungi	2.1		0.4			0.3	0.1	1.0	1.0
Sterile dark mycelium	0.2	0.1		0.9	4.5	0.6	0.1		8.4
Sterile white mycelium	0.2	0.6				1.7			6.4

*Freshly fallen liter.

Table 2

Relative abundance (%) of more frequent fungi isolated from the leaf litter of Tectona grandis during different months

Fungi	ff*	1985							1986
		May	June	July	Aug.	Sep.	Oct.	Dec.	June
Alternaria alternata (fr.) Keissler			8.9			0.4		0.4	
Alternaria sp.		0.8		0.6	0.4				
Aspergillus flavus		4.2	1.0	1.7	5.0	1.9	2.4		0.7
A. niger		6.3	20.3	35.4	18.5	8.1	4.8	16.5	11.3
Aspergillus spp.	46.5	11.8	32.9	1.1		8.5	25.2	46.4	18.7
C. oxysporum Berk. & Curt.		0.8		1.1	1.2				
Coniella granati (Sacc.) Petrak & Sydow	1.3				0.4				
C. lunata	0.2	1.3	1.2	6.3	1.2	6.6			3.5
Doliomyces mysorensis		11.3			5.4				
Fusarium solani						12.0			0.4
Fusarium spp.		0.4			9.5	4.2	4.5		9.2
Humicola grisea Traaen				0.6		0.4			
Monodictys sp.					1.2	1.2	2.0		2.0
Mucor sp.							0.4		5.3
Myrothecium roridum Tode ex Steudel	0.2	4.6					3.7	0.4	
Myrothecium sp.			0.2			4.6		0.4	0.7
Penicillium sp.	40.9	12.2	17.3	17.7	2.1		4.5	3.0	1.1
Pestalotiopsis sp.				2.9		1.5	0.4	0.4	
Phoma spp.		22.3		7.4	19.8	22.0	4.1	2.2	20.4
Pyrenochaeta sp.	0.2			6.3		3.5	2.0		
Robillarda sp.		15.5		11.0	5.8	5.0	19.0		2.5
Scolecobasidium variabile Barron & Busch	0.2								0.4
Scytalidium lignicola		0.4				2.7	0.4	0.4	
Syncephalastrum racemosum		1.3	1.5		0.8	0.8		0.4	
Trichoderma viride				1.7		6.9	9.3	2.3	1.4
Trichoderma sp.								7.5	1.8
Ulocladium atrum			11.6	0.6	0.8			13.1	0.4
Unidentified fungi	3.3		0.2	1.1	3.7	4.2	2.5	4.1	1.8
Sterile dark mycelium	0.8	0.8	1.2	2.3	5.8	3.4	12.6	0.4	8.8
Sterile white mycelium	1.0	2.1	0.2	0.6	7.0	0.8	0.4	0.7	7.7

*Freshly fallen litter

dominant forms included *Alternaria*, *Scytalidium* and *Syncephalastrum*. Fungi namely, *Beltrania rhombica* O. Penzig, *Botryodiplodia theobromae* Pat, *Bipolaris spicifera*, *Chaetomella circinoseta* Stolk, *Cladosporium cladosporioides*, *Curvularia brachyspora* Boedijin, *C. pallescens* Boedijin, *C. senegalensis*, *C. verruciformis* Agarwal & Sahni, *Geotrichum candidum* Link, *Graphium* sp., *Humicola fuscoatra* Traaen, *Myrothecium verrucaria* (Alb. & Sch), *Paecilomyces* sp., *Rhizopus* sp., *Robillarda sessilis*, *Thielavia* sp., *Torula* sp., *Tritirachium* sp. and *Ulocladium botrytis* Preuss, were isolated only once during the study period.

In both the litters, the Zygomycetous fungi appeared mostly on highly decomposed litter. The sterile forms (basidiomycetous mycelium) were also dominant during the advanced stages of decomposition.

Discussion

The concept of fungal succession on decaying plants and other substrates is now well established (Hudson, 1968; Hayes, 1979). The complex of factors that mediate succession embraces changes in the microhabitat, including nutritional relationships of the substrate and antagonistic effects (Macauley and Thrower, 1966).

The results show that a good number of fungi are common to both *Albizia* and teak litters while a few others are restricted to each type of litter. This may be due to the occurrence of species specific fungi (Macauley and Thrower, 1966). But the possibility of a chance occurrence of certain species of fungi on a particular litter cannot be overruled. However, in spite of this difference, a general pattern of colonization by fungi is evident in this study.

The primary colonizers of the litters were members of fungi imperfecti and most of these showed their dominance throughout the decomposition period. Aspergilli followed by Penicillia were the two most-dominant colonizers of *Albizia* and teak litters. The initial colonisers of the litters also included species of *Curvularia*, *Cladosporium* and *Alternaria*. The secondary colonizers of litter also comprised of several genera of fungi imperfecti. Member of Ascomycetes were rare. The Basidomycetes (sterile mycelia) were dominate during the advanced stage of decomposition.

It is evident from the results that fungi imperfecti are active colonizers of *Albizia* and teak litters as they showed higher frequency of occurrence and relative abundance than other fungi. There are several reports on the preponderance of fungi imperfecti on decomposing litter (Shukla *et al.*, 1978; Macauley, 1979; Pugh, 1974). This may be related to their high sporulating ability and fast growth. Several genera belonging to this group are known to be very active cellulose decomposers (Domsch *et al.*, 1980). The dominance of Aspergilli and Penicillia on decaying leaf litters was reported by several workers (Pugh, 1974; Soni, 1985). The abundance of Aspergilli and Penicillia can be attributed to their ubiquitous nature and ability to grow over a wide range of temperatures, pH, mcisture content and a range of substrates (Pugh, 1974).

The nutrient requirement of most of the Ascomycetes are exacting and this may be one of the reasons for their low frequency in dilution plates. The slow growth and weak parasitic nature of this group of fungi may have also contributed to their low frequency and abundance. As the

Basidiomycetes were seldom encountered in dilution plates their activity could not be fully assessed. However, most of the sterile forms recovered during the isolations were recognised to have Basidiomycetous mycelium. Pugh (1958) and Macauley and Thrower (1966) have reported that Zygomycetes are isolated most frequently during the final stages of decomposition of litters. In this study also, the members of Zygomycetes were more frequent and dominant on highly decomposed litter. In general, evidence presented in this paper adds further support to Hudson's (1968) hypothesis on succession of fungi on decaying plant litters. However, species of *Penicillium* colonized the *Albizia* and teak litters at all the stages of decay. This observation is at variance with Hudson's hypothesis where he postulated that various soil inhabitants including species of Penicillia appear only during the final stages of decay.

The leaf litter mycoflora of teak reported here is broadly consistent with the litter fungi of teak listed by Sinha and Dayal (1983) from Varanasi and Soni (1985) from Jabalpur. Regarding the composition of the flora, the results are more in agreement with those of Soni (1985). The successional patterns of major groups of fungi were similar in all the three studies. This shows that despite the variations in climatic and soil factors between the three locations of study, teak leaf litter harboured a more or less identical fungal flora. This study, thus provides further proof that substrate quality is a major factor which influences the composition of the fungal flora of leaf litters.

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SUMMARY

Fungi associated with the decomposition of leaf litters of *Albizia* and teak were studied for a period of 14 months using the dilution plate method. Aspergilli, Penicillia, *Doliomyces mysorensis*, *Robillarda sessilis* and *Trichoderma viride* were the dominant primary saprophytes of *Albizia* litter. Teak litter had Aspergilli, Penicillia, *Coniella*, and *Tritirachium* sp. as the dominant early colonizers. The secondary colonizers of both the litters included several gerera of fungi imperfecti and sterile forms. Members of Mucorales and the Basidiomycetous mycelium were predominant on highly decomposed litter. Fungi imperfecti were the dominant colonizers of the litters throughout the study period. In general, the successional pattern of fungi on *Albizia* and teak litters agreed with the general scheme of fungal succession on plant litters proposed by Hudson. The mycoflora of teak litter reported in this study was more or less identical to that reported from elsewhere. It is concluded that possibly substrate quality is one of the major factors which influence the composition of fungal flora of leaf litters.

केरल में सागौन और *एल्बिज्जिया* के पर्णास्तरण के विघटन से सम्बद्ध कवक

के० वी० शंकरन

सारांश

तनूकरण प्लेट रीति द्वारा *एल्बिज्जिया* और सागौन के पर्णास्तिरण के विघटन से जुडे हुए कवकों का 14 महीने तक अध्ययर किया गया। *एल्बिज्जिया* के पर्णास्तरण के प्रमुख प्राथमिक मृतोपजीवी कवक एस्परगिली, मेनिसिलिन, *डोलिमाइसेस माइसोरेंसिस, रोबिलार्डा सेसाइलिस* और *ट्राइकोडेर्मा विरिडे* रहे। सागौन के पर्णास्तण में एस्परगिली, पेनिसिलिन, *कोनिएल्ला, ट्रिटिरेक्यिम* जातियाँ प्रमुख पूर्व उपनिवेशक रहे। दोंनो जातियों के द्वितीयक उपनिवेशियों में अनेक कवक प्रजातियों के अपूर्ण कवक और बन्ध्य रुप सम्मिलित थे। म्यूकरईज और बेसिडिओमाइसेटस जालक अत्यधिक विघटित पर्णास्तरण पर अति प्रमुख रहे। अपूर्ण कवक अध्ययन की समूची अवधि में पर्णास्तरण पर प्रमुख उपनिवेशी रहे। सामान्यत। *एल्बिज्जिया* और सागैन के पर्णास्तरण में कवकों की कृमिक रुप-सज्जा हडसन द्वारा पादप पर्णास्तरण के लिए प्रस्तावित कवकों की क्रमिक उत्तरोत्तरता के अनुरुप ही थी। इस अध्ययन में सूचित किए गए सागौन के पर्णास्तरण के कवक लगभग वे ही थे जो अन्यत्र सूचित किए गए हैं। निष्कर्ष यह है कि उपस्तर की संभावित गुणवत्ता उन बड़ें कारकों में से एक है जो पर्णास्तरण के कवकों के गठन पर प्रभाव डालते हैं।

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ECO-BIOGEOGRAPHY OF ARID ZONE (THAR DESERT) TERMITES (INSECTA : ISOPTERA)

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Introduction

Adams (1899), was the first to mention about termites in the western portion of Thar desert. Desneux (1906), gave a good account of a few species from the Sind portion of the desert. Ahmad (1955), gave a taxonomic account of the termites of Pakistan, (including Sindh). Roonwal and Bose (1964), reported 19 species and sub-species under 12 genera from Rajasthan, which forms the major portion of Thar desert (62%). Roonwal (1975), while dealing with exclusively on desert termites listed 17 species, under 3 families and 10 genera. Roonwal and Verma (1977), raised the number of species to 32 from Rajasthan, of which 27 were recorded from the Thar desert (Roonwal, 1976, 1982). Recently, Thakur (1981), reported 53 species from Indian arid zones, which also included Southern Arid Zone. However, so far there was no published record of termites from arid areas of Gujarat, Haryana and Punjab. The author travelled extensively in Thar desert and recorded 27 species (Thakur, 1984, 1985, 1989a, b) from arid areas of Gujarat and 21 species from Punjab and Haryana. Consequent to the above studies, the termite fauna of Thar desert is now quite well known and as many as 41 species are found at present in the arid region. In the light of the taxonomic composition now available endemism, zoogeography and ecological relationships are discussed.

Physiography

The Thar desert comprises a large area of about 446,080 km^2 in Western India, Pakistan and is commonly called as the Great Indian Desert. It forms the eastern extremity of the Great Palaearctic Desert, which extends from North Africa, via Palestine, Arabia and Iran, to North-Western India (Roonwal, 1982). It is bounded by the Aravalli hills on the east, on the west by the fertile Indus and Nara Valley, on the south by the grand Salt marsh of Kachchh and in the north by a few districts of Haryana, Punjab (in both India and Pakistan). Roughly the northern and southern limits are 30° N and 21° N lat. and 69° E and 75° E long. (Gupta and Prakash, 1975). The major arid areas are contained in Rajasthan (196,150 km^2, 62%), followed by Gujarat (62,180 km^2, 20%), Punjab (14,510 km^2, 5%) and Haryana (12,840 km^2, 4%) in India and 1,67,750 km ^{2} in Pakistan (Sind-82,750 km ^{2}, Punjab-85,000 km^2).

Climate

High temperatures in summer (max. reaching 50°C) and low, freezing temperatures in winter; low and erratic rainfall distribution, high evaporation, annual precipitation being less than the potential evaporation (below 30 cm in certain parts); extreme variations of diurnal and annual

temperatures and large shady tree less areas, often formed into high, shifting sand dunes (Roonwal, 1982) characterise the area.

Vegetation

Characteristic vegetation is open scrubs of low bushes and thorns, stunted trees, mostly xerophytic plants, viz., species of *Acacia, Calotropis, Capparis, Euphorbia, Prosopis* and *Zizyphus*, etc, and some species of grasses in the western portion. In the southeast portions of the Thar desert some broad leaved tree species are well frequented, such as *Anogeissus, Bombax, Butea, Prosopis, Eugenia, Terminalia* and Teak (Thakur, 1981).

Composition and Zoogeography

The Thar desert comprises 14 genera and 41 species under 5 families (Table 1) and represent about 20% of the total Indian termite fauna. The primitive families are rather poorly represented, e.g., Kalotermitidae (1 genus, 7.14%; 1 species, 2.44%); Hodotermitidae (1 genus, 7.14%; 1 species, 2.44%), and Rhinotermitidae (3 genera, 21.42%; 3 species, 7.32%), all constituting 5 genera (35.7%) and 5 species (12.2%), while the bulk of the remaining component (9 genera, 64.3% and 36 species, 87.8%) belong to higher termites of the families Macrotermitidae and Termitidae. The family Macrotermitidae is represented by 2 genera (14.28%) and 20 species (48.78%) whereas among the family Termitidae, the sub-family Amitermitinae occupies the top position with 5 genera (35.74%) and 14 species (34.14%), followed by Termitinae and Nasutitermitinae both sharing 1 genus (7.14%) and 1 species (2.44%) each (Table 2).

The zoogeographical analysis of the termite fauna of the Thar desert, which in its facies, is overwhelmingly Oriental, is largely Ethiopian in origin (73.17%), small amount of Oriental (14.63%) and sharing equally between Neotropical and Palaearctic regions (2.44% each), while 7.32% is of obscure origin. The region exhibits a great deal of paucity in endemic species. Eight species (19.51%) are endemic to Thar desert. *Incisitermes didwanaensis, Microcero-termes laxmi, M. raja* and *Angulitermes jodhpurensis* are endemic to Rajasthan portion, whereas *Odontotermes girnarensis, O. paralatiguloides* and *O. sasangirensis* are endemic to Gujarat portion of the Thar desert. *Psammotermes rajasthanicus* is found in arid areas of both these States, however none of the endemic species is available in desert portions of Haryana and Punjab. None of the genera concerned is endemic, some have an Ethiopian origin (*Psammotermes, Microcerotermes* and *Odontotermes*), one an Oriental origin (*Angulitermes*), while the primitive genus *Incisitermes* has an obscure origin. Eight species (19.51%), which are common to Gujarat, Haryana, Punjab and Rajasthan portion, are *Heterotermes indicola, Odontotermes gurdaspurensis, O. latiguloides, O. obesus, Microtermes mycophagus, M. obesi, M. unicolor* and *Trinervitermes biformis*. However, a scrutiny of the distribution of these species reveals a wider range of distribution in the greater part of the Indian sub-continent. The rest of the fauna has a wider adaptability to varied ecological conditions of soil and vegetation and higher rainfall and are found widely distributed in their areas as well.

Ecological Relationships

The principal ecological factors which influence the abundance, distribution and

Table 1

Zoogeographical distribution of the Termite species of Thar Desert.

Species	Thar Desert Portions								Zoogeo-graphi-cal status	Ende-mism	Origin of Species
	Punjab	Haryana	Gujarat	Rajasthan	Pakistan	North India above 20° N'	Penin-sular India below 20° N'	Outside India			
1	2	3	4	5	6	7	8	9	10	11	12
Family I. Kalotermitidae											
1. *Incisitermes didwanaensis* (Roonwal & Verma)	-	-	-	+	-	-	-	-	Or.	+	?
Family II. Hodotermitidae											
2. *Anacanthotermes macrocephalus* (Desneux)	-	-	+	+	+	-	-	+ Afghanistan	Pal.	-	Pal.
Family III. Rhinotermitidae											
Subfamily (a). Psammotermitinae											
3. *Psammotermes rajasthanicus* (Roonwal & Bose)	-	-	+	+	-	-	-	-	Or.	+	Eth.
Subfamily Heterotermitinae											
4. *Heterotermes indicola* (Wasmann)	+	+	+	+	+	+	-	+ Bangladesh	Or.	-	?
Subfamily (c). Coptotermitinae											
5. *Coptotermes heimi* (Wasmann)	+	-	+	+	+	+	+	+ Bangladesh	Or.	-	Or.
Family IV. Macrotermitidae											
6. *Odontotermes assmuthi* (Holmgren)	+	-	+	-	+	+	+	-	Or.	-	Eth.
7. *Odontotermes bellahunisensis* (Holmgren & Holmgren)	+	+	+	-	-	+	+	-	Or.	-	Eth.

(Contd.)

1	2	3	4	5	6	7	8	9	10	11	12
8. *Odontotermes brunneus* (Hagen)	-	+	+	+	-	+	+	+ Sri Lanka	Or.	-	Eth.
9. *Odontotermes dehraduni* (Snyder)	-	-	-	+	+	+	-	-	Or.	-	Eth.
10. *Odontotermes distans* (Holmgren & Holmgren)	-	-	+	+	+	+	+	+	Or.	-	Eth.
11. *Odontotermes giriensis* (Roonwal & Chhotani)	+	+	-	+	-	+	-	+ Bhutan	Or.	-	Eth.
12. *Odontotermes girnarensis* (Thakur)	-	-	+	-	-	-	-	-	Or.	+	Eth.
13. *Odontotermes gurdaspurensis* (Holmgren & Holmgren)	+	+	+	+	+	+	-	-	Or.	-	Eth.
14. *Odontotermes indicus* (Thakur)	+	-	-	-	+	+	+	-	Or.	-	Eth.
15. *Odontotermes latiguloides* (Roonwal & Verma)	+	+	+	+	-	-	-	-	Or.	-	Eth.
16. *Odontotermes lokanandi* (Chatterjee & Thakur)	+	+	+	+	-	-	-	-	Or.	-	Eth.
17. *Odontotermes microdentatus* (Roonwal & Sen-sharma)	-	+	+	+	+	+	+	- Bangladesh, Bhutan & Burma	Or.	-	Eth.
18. *Odontotermes obesus* (Rambur)	+	+	+	+	+	+	+	+	Or.	-	Eth.
19. *Odontotermes paralatiguloides* (Thakur)	-	-	+	-	-	-	-	-	Or.	+	Eth.

1	2	3	4	5	6	7	8	9	10	11	12
20. *Odontotermes redemanni* (Rasmann)	+	+	+	+	-	-	-	-	Or.	-	Eth.
21. *Odontotermes sasangirensis* (Thakur)	-	+	+	+	-	-	-	-	Or.	-	Eth.
22. *Odontotermes wallonensis* (Wasmann)	-	+	+	+	-	+	+	+	Or.	-	Eth.
23. *Microtermes mycophagus* (Desneux)	+	+	+	+	+	+	-	-	Or.	-	Eth.
24. *Microtermes obesi* (Holmgren)	+	+	+	+	+	+	+	+ Bangladesh Sri Lanka	Or.	-	Eth.
25. *Microtermes unicolor* (Snyder)	+	+	+	+	+	+	+	+ Sri Lanka	Or.	-	Eth.
Family V. Termitidae											
Sub-family (a) Amitermitinae											
26. *Speculitermes cyclops* (Wasmann)	+	-	-	-	+	+	+	-	Or.	-	Neo.
27. *Amitermes belli* (Desneux)	+	-	+	+	-	-	-	+	Or.	-	?
28. *Synhamitermes quadriceps* (Wasmann)	-	-	+	-	-	-	+	+ Bangladesh	Or.	-	Or.
29. *Eremotermes fletcheri* (Holmgren and Holmgren)	-	-	+	-	-	-	-	-	Or.	-	Or.
30. *Eremotermes neoparadoxilis* (Ahmad)	-	-	-	+	+	+	-	-	Or.	-	Or.
31. *Eremotermes paradoxalis* (Holmgren)	-	-	-	+	+	+	+	+	Or.	-	Or.

(Contd...)

1	2	3	4	5	6	7	8	9	10	11	12
32. *Microcerotermes baluchistanicus* (Ahmad)	-	-	-	-	+	-	-	-	Or.	-	Eth
33. *Microcerotermes cameroni* (Snyder)	-	-	+	-	-	-	+	-	Or.	-	Eth.
34. *Microcerotermes heimi* (Wasmann)	-	-	+	-	-	-	+	-	Or.	-	Eth.
35. *Microcerotermes laxmi* (Roonwal & Bose)	-	-	-	+	-	-	-	-	Or.	-	Eth.
36. *Microcerotermes palestinensis* (Spaeth)	-	-	+	+	-	-	-	-	Or. Israel	-	Eth.
37. *Microcerotermes raja* (Roonwal & Bose)	-	-	-	+	+	-	-	-	Or.	-	Eth.
38. *Microcerotermes sakasarensis* (Ahmad)	-	-	-	+	+	-	-	-	Or.	-	Eth.
39. *Microcerotermes tenuignathus* (Holmgren)	+	-	+	+	+	+	-	-	Or.	-	Eth.
Sub-family (b) Termitinae											
40. *Angulitermes jodhpurensis* (Roonwal & Bose)	-	-	-	+	-	-	-	-	Or.	-	Or.
Sub-family (c) Nasutitermitinae											
41. *Trinervitermes biformis* (Wasmann)	+	+	+	+	+	+	+	+ Sri Lanka	Or.	-	Eth.

*Abbreviations : + Present; - Absent; Eth., Ethiopian; Neo., Neotropical; Or., Oriental; Pal., Palaeartic.

Table 2

Distribution of Termites of the Thar Desert

Family Subfamily	No. of genera	%	No. of species	%
Kalotermitidae	1	7.14	1	2.44
Hodotermitidae	1	7.14	1	2.44
Rhinotermitidae	3	21.42	3	7.32
Psammotermitinae	1	7.14	1	2.44
Heterotermitinae	1	7.14	1	2.44
Coptotermitinae	1	7.14	1	2.44
Macrotermitidae	2	14.28	20	48.78
Termitidae	7	50.02	16	39.02
Amitermitinae	5	35.74	14	34.14
Termitinae	1	7.14	1	2.44
Nasutitermitinae	1	7.14	1	2.44

dispersal of termites, are rainfall, temperature, humidity, vegetation and soil types. Of these, vegetation and soil types are perhaps more important than others (Thakur, 1981). Among the Thar desert termites some species, viz., *Anacanthotermes macrocephalus, Psammotermes rajasthanicus, Microcerotermes laxmi, M. raja* and *Angulitermes jodhpurensis* occur exclusively in areas, having less than 300 mm of rainfall. *A. macrocephalus* and *P. rajasthanicus* have also been recorded from the semi-arid areas in India and Pakistan (Choudhary and Ahmad, 1972; Thakur, 1989a). Four species habitually inhabit wood, out of which *Incisitermes didwanaensis* (Family Kalotermitidae is an exclusively wood dwelling whereas *Psammotermes rajasthanicus, Heterotermes indicola* and *Coptotermes heimi* (Family Rhinotermitidae) maintains soil connections for moisture requirements and reach wood sources through earthern gallery system. *Trinervitermes biformis* is absent in extreme dry arid conditions and prefer mainly semiarid and wet open areas. The species of genera *Speculitermes, Amitermes, Synhamitermes, Eremotermes,. Microcerotermes, Odontotermes* and *Microtermes* are versatile with wide tolerance limit and may occur in all types of climates.

With regards to vegetation, *A. macrocephalus, P. rajasthanicus, Amitermes belli, Eremotermes fletcheri, Microcerotermes palestinensis* have been recorded in areas with little vegetation, but is also found in open scrub. Some species of genera *Coptotermes, Speculitermes, Eremotermes, Microcerotermes, Odontotermes, Microtermes* and *Trinervitermes* seem to prefer open scrub, though some of them have been found in the forest also (*Synhamitermes quadriceps* and *Odontotermes indicus*). However majority of the species are versatile and are found in all types of vegetations, some of them occurring in cultivated areas and are serious pests of agriculture, horticulture and forestry (Thakur, 1985).

Since the majority of termites are subterranean in habit and carry out various activities underground, soil types perhaps join hands with vegetation types in influencing the distribution and abundance of termites. Among Thar desert termites, except *Incisitermes didwanaensis*, which is purely wood dwelling species, the remaining species are soil dwelling. Among these, *A. macrocephalus* and *P. rajasthanicus* generally prefer sandy gravely soils. *A. macrocephalus* can be termed as truly desert species and it builds its nests deep in the ground (recorded as deep as 4 metres, Roonwal, 1970) and make long tunnels, as long as about 20 metres away. *Microcerotermes laxmi, M. sakesarensis* and *Angulitermes jodhpurensis* are confined to sandy desert soil with scrubby vegetation. Other species are more adaptable and occur in several types of soil. Those which show the widest degree

of tolerance and are found in all available soil types are *Eremotermes paradoxalis, Odontotermes indicus, O. microdentatus, O. obesus* and *Microtermes obesi* (Roonwal, 1976). *Trinervitermes biformis* prefers open areas and have been observed to construct small conical mounds in non-arid areas of Gujarat (Amreli and Ghandinagar; Thakur, 1989a).

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SUMMARY

Altogether 41 species are known from the Thar desert, distributed over five families and 14 genera, viz., Family Kalotermitidae: *Incisitermes* **(1 sp.); Family Hodotermitidae:** *Anacanthotermes* **(1 sp.); Family Rhinotermitidae:** *Psammotermes* **(1 sp.),** *Heterotermes* **(1 sp.),** *Coptotermes* **(1 sp.); Family Macrotermitidae:** *Odontotermes* **(17 spp.),** *Microtermes* **(3 spp.); Family Termitidae:** *Speculitermes* **(1 sp.),** *Amitermes* **(1 sp.),** *Synhamitermes* **(1 sp.),** *Eremotermes* **(3 spp.),** *Microcerotermes* **(8 spp.),** *Angulitermes* **(1 sp.), and** *Trinervitermes* **(1 sp.), In the light of taxonomic composition, zoogeography and endemism have been discussed. The termite fauna of Thar desert is overwhelmingly Oriental (40 species), with only a small fraction of Palaearctic origin (1 species). Eight species are endemic to Thar desert, 4 species being confined to Rajasthan portion, 3 species to Gujarat portion whereas 1 species is available in desert areas of both these states. With respect to the ecological factors, such as rainfall, temperature humidity, vegetation and soil types, their relationship with the abundance, distribution and dispersal of termites have been discussed. Their adaptability to varied ecological conditions are discussed.**

शुष्क क्षेत्र (थार मरु) की दीमकों (कीटा : वल्मा) का परिस्थिति जैवभूगोल

आर0 के0 ठाकुर

सारांश

कुल मिलाकर थार मरू के 5 वंशों और 14 प्रजातियों की 41 जातियों की अर्थात् वंश कैलोटर्माइटिडि : *इनसाइजीटर्मिस* (एक जाति), वंश होडोटर्माइटिडि : *एनाकैन्थोटर्मिस* (एक जाति), वंश राइजोटर्माइटिडि : *सैम्मोटर्मिस* (एक जाति), *हीटरोटर्मिस* (एक जाति), *कोप्टोटर्मिस* (एक जाति), वंश मैक्रोटर्माइटिडि : *ओडोण्टोटर्मिस* (17 जातियां), *माइक्रोटर्मिस* (दो जातियां), वंश टर्माइटिडि : *स्पैकुलिटर्मिस* (एक जाति), *एमिटर्मिस* (एक जाति), *सिनहेमिटर्मिस* (एक जाति), *एरिमौटर्मिस* (तीन जातियां), *माइक्रोसेरोटर्मिस* (आठ जातियां), *एंगुलिटर्मिस* (एक जाति), और *ट्राइनर्वोटर्मिस* (एक जाति), की दीमकों का पता है। वर्गीकारिकी रचना की दृष्टि से इनके प्राणि भूगोल और एकदेशिकता का विवेचन किया गया है। इस मरू भूमि की दीमकें भारी मात्रा में पौवत्यि (40 जातियां) हैं। और उनका बहुत थोड़ा भाग प्राक् उत्तरध्रुवीय उद्गम (एक जाति) का है। आठ जातियां थार मरू में ही मिलती हैं, चार जातियां केवल राजस्थान वाले भाग में, तीन गुजरात वाले भाग में तथा एक जाति इन दोनों राज्यों के मरू प्रदेशों में मिलती हैं। पारिस्थितिकीय कारकों की दृष्टि से जैसे वर्षा, तापमान, आद्रता, वनस्पति, मृदा प्ररूप, प्रचुरता से उनके संबंध, वितरण तथा दीमकों के प्रसरण का अध्ययन किया गया है। विभिन्न पारिस्तिथिकीय दशाओं के साथ उनकी अनुकूलनीयता का विवेचन भी किया गया है।

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RESEARCH NOTE

STUDIES ON SEED POSITION AND THEIR EFFECT ON GERMINATION AND SEEDLING SURVIVAL IN *DALBERGIA SISSOO* ROXB.

Dalbergia sissoo Roxb. is an important timber tree. It can easily be raised from seeds. The size of the pod varies from 5 cm to 10.5 cm according to the number of seeds (Table 1). During the study 1-4 seeded pods were observed in the sampling trees. Amongst them 2-seeded pods are very common followed by 1-seeded and 3-seeded whereas 4-seeded pods are very rare. The study was performed as follows :

Seeds were collected from the trees growing in the substandard soil of Banthara Research Station, near Lucknow. Germination studies were divided into two parts

(i) In the first part, study was carried out on the seeds extracted from 1-seeded, 2-seeded and 3-seeded pods.

(ii) The second part of the study deals with the seeds extracted from upper, middle and lower part of the 3-seeded pod. Both parts of study were performed at Laboratory conditions (25° - 30°C). At first seeds of each part of study were surface sterilized by 0.1% mercuric chloride solution for 2 minutes. Four replicates of 25 seeds of each were kept in petri dishes (15 cm diameter) lined with whatman No. 1 filter paper over wet cotton beds. Distilled water was used as germination medium.

Germination was started from the next day of sowing and completed within 5-6 days. Seed germination was observed daily and counts were taken regularly upto completion of germination. For the further study seedlings were planted in earthen pots filled with field and road soil (3 : 1).

It was observed that germination percentage of the seeds extracted from 2-seeded

Table 1

Types of pods and germination percentage						Position of seeds, percentage of their germination and seedling survival					
1-seeded pod		2-seeded pod		3-seeded pod		Seeds extracted from upper part of the pod		Seed extracted from middle part of the pod		Seeds extracted from lower part of the pod	
Av. size of the pod	Germination (%)	Av. size of the pod	Germination (%)	Av. size of the pod	Germination (%)	Germination (%)	Seedling Survival	Germination (%)	Seedling Survival	Germination (%)	Seedling Survival
5.2 cm	93	8.5 cm	100	9 cm	100	100	20	80	50	60	30

and 3-seeded pods was highest in comparision to 1-seeded pods. In 3-seeded pods, upper seeds were highly germinable but having lowest seedling survival, while seeds having the middle position inside the pod were fairly high germinable but their seedling survival was highest (Table 1).

Present study revealed that seed position in pod may significantly affect the percentage of seed germination and their seedling survival, therefore in *Dalbergia sissoo* collection of 2-seeded and 3-seeded pods should be done for better regeneration of trees.

Seed Biology Laboratory,
National Botanical Research Institute,
Lucknow (U.P)

Kanak Sahai

From the Indian Forester—One Hundred Years Ago

THE INDIAN FORESTER

May, 1894 (pp. 168-171)

ALLUVION AND DILUVION

In the *Indian Forester* for Febuary 1894, a correspondent (G.E.M.) on the subject of "Protected Forests", (p. 59) asked a question about the *Rule of alluvial additions* to *Forest estates*, which I will endeavour to answer, as he requests. I have not heard yet of any attempt to replace the old Bengal Regulation XI of 1825, which is still the General Law on the subject.

On Alluvion - The defect of this Regulaton is, that it allows its own rules as to ownership to be over-ridden in all cases where there is any other rule of *local custom*. Now, in a country, like the Punjab or Sindh, where there are many rivers, or at any rate a great deal of river action going on, there are pretty sure to be *customs,* and these customs are usually very various and quite unsuited to modern requirements, such as the local customary rule that the 'deep stream' was always the boundary, and that a man lost his land if the river changed. Clearly this was due to old days of feuds and wars, when the owners were kept from each other's throats only by an unfordable stream between them! And the customs were, in fact, invented in old days, when, owing to the hostility of tribes, villages and petty States or Kingdoms, special arrangements were needed, in case a village separated at one time from its neighbour by a stream should become united to it by that stream changing course. But I cannot go into the whole subject of alluvial law, and will come at once to the particular point in question.

The action of rivers coming down from the hills on to comparatively soft and nearly level alluvial plains is not difficult to understand. They have no real bed, for at least a part of their course: as they rise with the melting of mountain-snows or the 'monsoon' rains, they spread abroad and again decrease splitting up into a number of branches in so doing, because the tendency of the main stream, laden with alluvial mud, is always to pile up the central bed to a slightly higher level than the rest. This level being overtopped in a high flood the water away on this side and on that as the obstacles of nature and lines of least resistance suggest. Practically, two chief results are found to affect riverain property. In the one case (1) samll and gentle accretions of soil are found to form up in front ('mahaz' in the native term) of the existing front; or the reverse action may take place, and little by little the area is cut away. Or, (2) a more marked change may take place, which the old Roman writers fancifully called 'avulsion' : here the land itself remains, (except so far as its surface may be swept over and injured); what happens is that the stream which before flowed in *front* of an estate now flows *behind* it, or on some other side; and hence what was

once a river bed, becomes (in time) dry land, and two estates formerly separated are now close neighbours; and here probably the deserted bed will be divided between them. Of course it is not possible that an area on one side of a river should really be torn off, and float houses, trees and all over to the other side, though this is implied by the word 'avulsion', it is the river course that changes, not the land.

Of course it is not always easy to tell what is going on. For a stream may really be changing its course, and yet do so little by little that the changes appear to be cases of accretion and diminution, and each flood-season takes the water a little further; with the effect that the - (A) Estate on one bank seems a to be (at the moment) only gaining a little by accretion, and the opposite estate (B) losing a little: but in time, the whole of B is gone; and if the river continues retreating, A has now become increased by the entire area, which was once B, or at least by so much of it as is not still occupied by the new course of the shifting river. It is in a case of this sort that the question noted by your correspondent arises. It has also frequently occurred, in cases when the *general* direction of the river has not suddenly altered, but still there is a slight tendency to move one way or the other locally. In such a case there may be two villages X and Y; at present Y is the riparian (or riverain) village and X is just behind it (inland), and therefore has no river frontage; but as the river slowly changes, Y is gradually eaten away, and in time X *becomes* the riparian. After a time a reverse action sets in, and the water slowly retires from X, or in other words new soil appears on the river front little by little.

Now the ordinary and well-known rule of law is that an accretion or "accessory" follows the same right of property as the principal. If a tree is mine, so (in the absence of express arrangements otherwise) is the fruit; and so will a cow and its calf. On exactly the same principle, a gradual accretion of mud, which in time hardens on to my frontier and increases my area is in general an `accessory'. It seems to come out of the river bed; and actually the estate opposite (on the other side) may not be suffering diminution, for the corresponding loss may be going on somewhere else and in several places. The object of the procedure for constituting a State (Reserved) or Protected Forest, is not, of course, to create proprietary right in the government where it did not exist before (I mean in general; for part of the procedure may be to obviate inconveniences by buying out little plots of private land and so aquiring the whole, and creating a proprietary right, but I refer to the effect on the area as a whole), but to define its limits, to dispose of claims to easements and other rights which might, if unknown and unprovided for, render management immpossible, and above all to announce that special protective rules of law will take effect within those limits which do not apply outside them. Consequently, the *gradual* increments on the river side, where in the nature of things there is no human neighbour, would hardly call for any fresh notificaton. Whenever an increment belongs to any tenure, all the incidents of the principal tenure attach to it (see Indian Law Reports, Calcutta Series, Vol.VII.479). The increment is clearly the property of the State, because the principal thing is. If, however, there were to a be permanent and large increase, it *might* be perhaps found best to *notify* it as Forest, because, though the *river* front or boundary would present no difficulty, neighbours on the other side might encroach, or begin to drive cattle to graze, or to cut 'tamarisk' on the new ground, and it would be desirable to declare it unmistakeably *under* the Forest Law; and

as no rights could possibly exist, the procedure under Chapter II would be merely formal. But here comes the second part of the queston. It is perfectly true that any gradual increment, large or small, to a riparian estate belongs to the estate : *but*, the case put by your correspondent, or illustrated by my villages X and Y (above) is different, for though truly X, formerly inland, has now *become* - though perhaps for forty years past - the riparian estate, still, it is known (and I assume *provable* by old maps, records, evidence, & c.) that Y *once* was there; so that the river lapping on X's shore and adding some strips of ground every season, is not merely *the river*: it is *water over Y's submerged village* - the *basis* of which is still in the depth below. Consequently, when land reappears on X's frontier, it is not a mere accretion to X, it is the *reappearance of Y*, and belongs to the owner of Y.

And this rule has been formally laid down by the Privy Council in the leading case of "*Lopez* versus *Modun-Thakoor*", reported in Moore's Indian Appeals.* It is the leading case well known to lawyers. There is a similar case in 4 Moore's Ind. Appeals, 403.

In the case put, it is not neccessary to discuss whether the doctrine is applicable in India that a man's property goes "down to the centre of the earth", because in some cases it does not, at least in the sense that mineral rights may belong to Government; but apart from that, there is no doubt that the *submersion* of any *known estate* by a river does not alter the ownership. In the case above alluded to, their Lordships said : "The site is the property; and the law knows no difference between a site covered by water and a site covered by crops, provided the ownership of the site be ascertained."

There is, therefore, no warrant for saying that in the case of a *known* or *provable* forest area, disappearing under river flow, and afterwards re-emerging (in proximity to the village estate, once immediately behind it, inland) that "according to existing Rules the forest is gone forever." No such rule is known to the law. Of course, the government's right to the forest area on its reappearing (or any other area) might be *again* lost, under the law of Limitation, by the owner ommitting to claim it for twelve years after its reappearance, but that is quite another matter: and in the case of a Government estate, the loss would not occur till *sixty* years had elapsed instead of *twelve*, without any claim to the restored acres.

The *law* is quite clear: but the practice may be different. Take the case of your correspondent's paper. In *principle*, no Court could hold that the Government was not entitled to the new found land: but suppose the *boundary* between the village and the Forest (where both were still unaltered) had never been properly defined or laid down, and there was some doubt about the real total area of the village estate, etc., it might be practically difficult to prove that the new land *was* on the site of the forest. A suit would certainly lie to recover the forest alluded to: it must be successful if the facts can be proved. In short, the rule of accretion may be stated thus :

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*Note : It will also be found reprinted in *Bangal Law Reports,* Vol. V, Privy Council Cases, page 521. Rattigan's (Punjab) Digest of Civil Law. Chap. XIII gives a convenient resume of the Alluvion Law, a great deal of which is not merely Punjab Law, but general, e.g., the rule of right to islands not attached to either shore, and is equally good Law eslewhere.

When the gradual accretion is really out of the river bed, it forms part of the estate to which it becomes attached, on the principle that the 'accessory follows the principal'; and as regards all rights and incidents of tenure. But when the accretion is not merely out of the river bed, but by the way of recovery of a washed away property now slowly coming back again, the new land is (on proofs of the facts) not an accretion to the neighbouring estate, but (as decided in "*Lopez* versus *Muddun Thakoor*") belongs to the original owner.

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The services of Smt. S. Kamala Sudarshana Rao, IFS (Kerala Cadre) who is under orders of posting as Principal, A.P. School of Forestry, Yellandu, are placed at the disposal of Social Welfare Department for appointment as Execution. Director, A.P. Scheduled Castes Co-operative Finance Corporation Limited.

Shri Siddiq Hassan Khan, Divisional Forest Officer (on leave) is posted as Assistant Field Director, Tiger Project, Achampet vice Shri Md. Badiuddin transferred.

Shri L. Krishna Bhoopal Rao, IFS (76), Conservator of Forests, Wildlife Management, Hyderabad is transferred and posted as Conservator of Forests (F.R. & I.) in the Office of the Principal Chief Conservator of Forests, in the existing vacancy.

Shri M. Sultan Mohiuddin, IFS (72) who is under orders of transfer as Conservator of Forests (F.R. & I.) in the Office of the Principal Chief Conservator of Forests, is retained as Conservator of Forests, Kurnool Circle.

Shri C. Madhukar Raj, IFS (75), Conservator of Forests, Warangal Circle, is transferred and his services are placed at the disposal of A.P. Forest Development Corporation Limited for appointment as Regional Manager. A.P. Forest Development Corporation Limited, Nellore vice Shri N. Linganna, IFS.

Shri Tej Singh Kardam, IFS (85), Divisional Forest Officer, Mancherial Division, is transferred and posted as Deputy Conservator of Forests (T.G.P), Office of the Principal Chief Conservator of Forest, Hyderabad vice Shri Kanwarjit Singh, IFS.

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The Governor, Himachal Pradesh is pleased to promote the following IFS (1980) officers to the Selection Grade of Rs. 4100-125-4850-150-5300 with effect from 1-7-1993:

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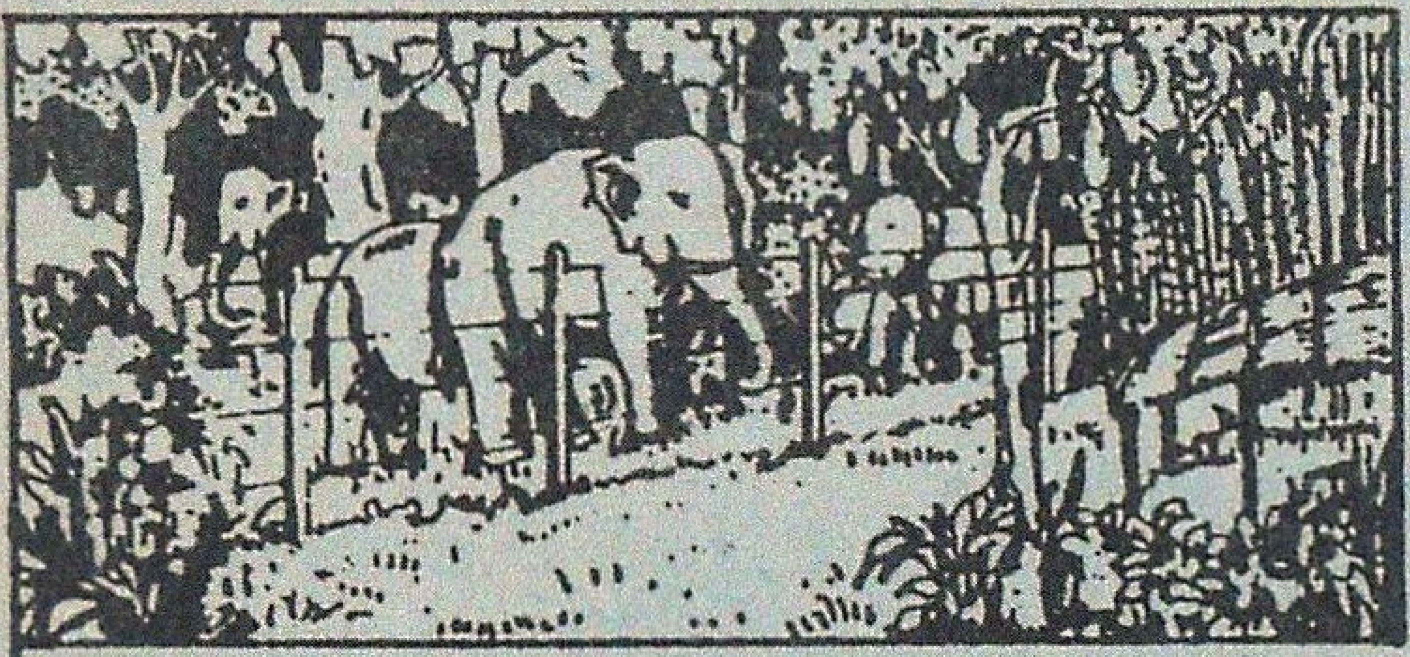

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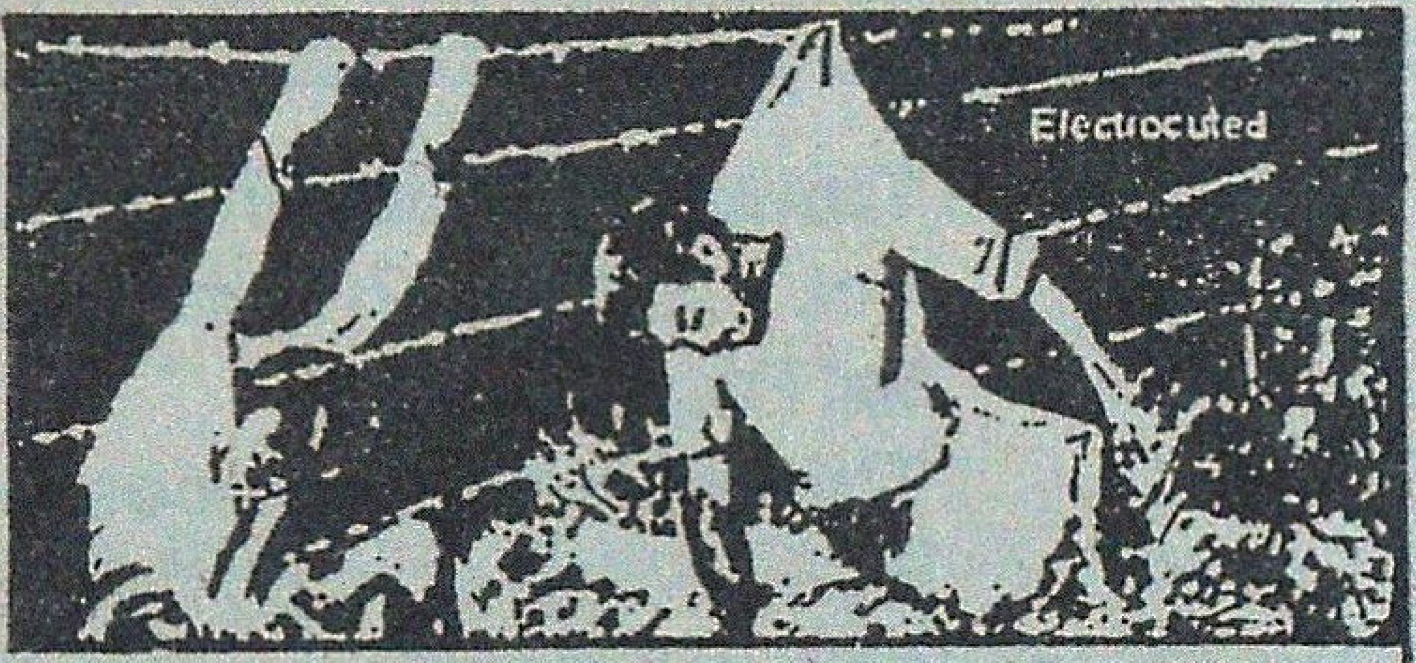

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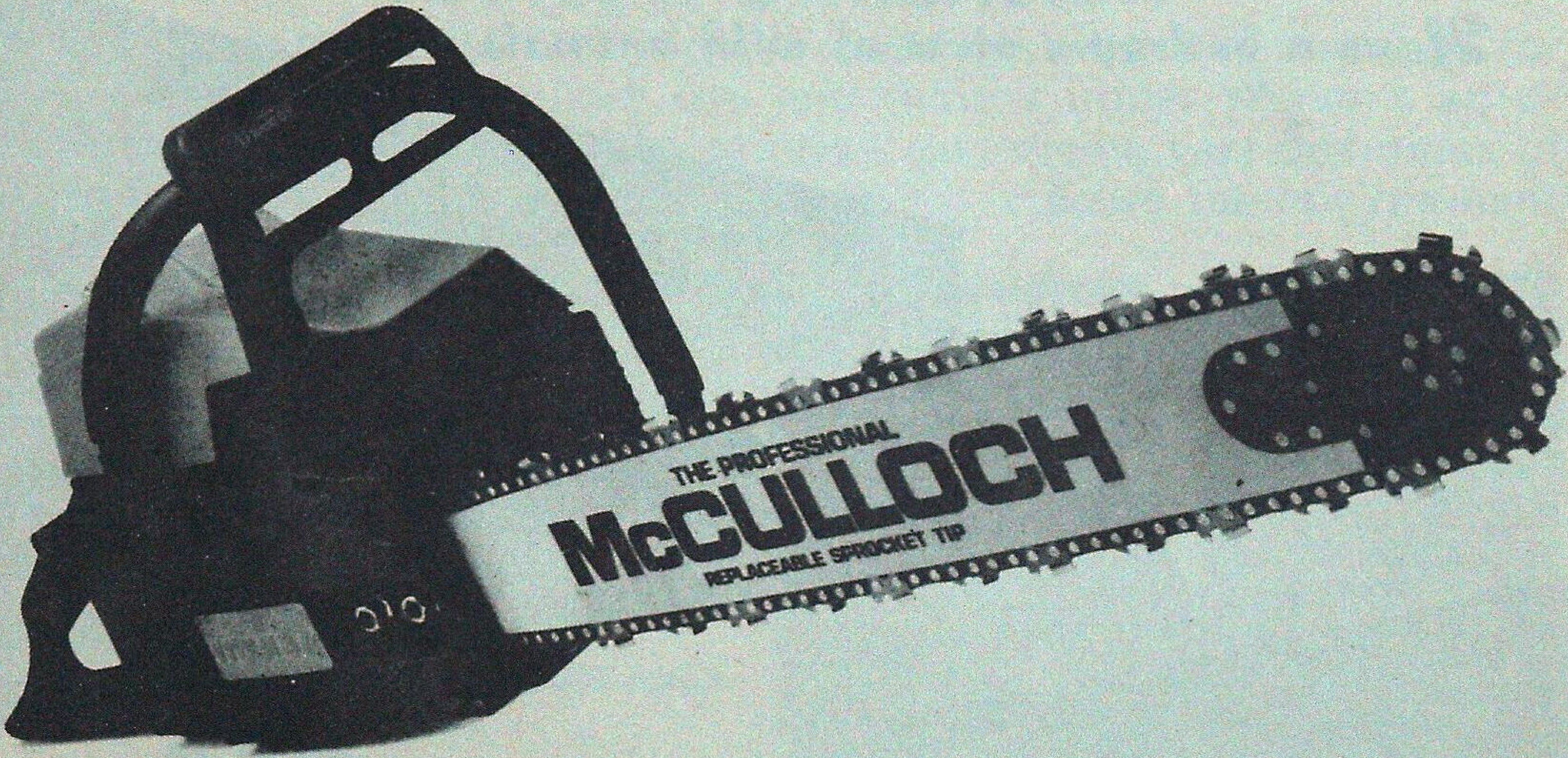

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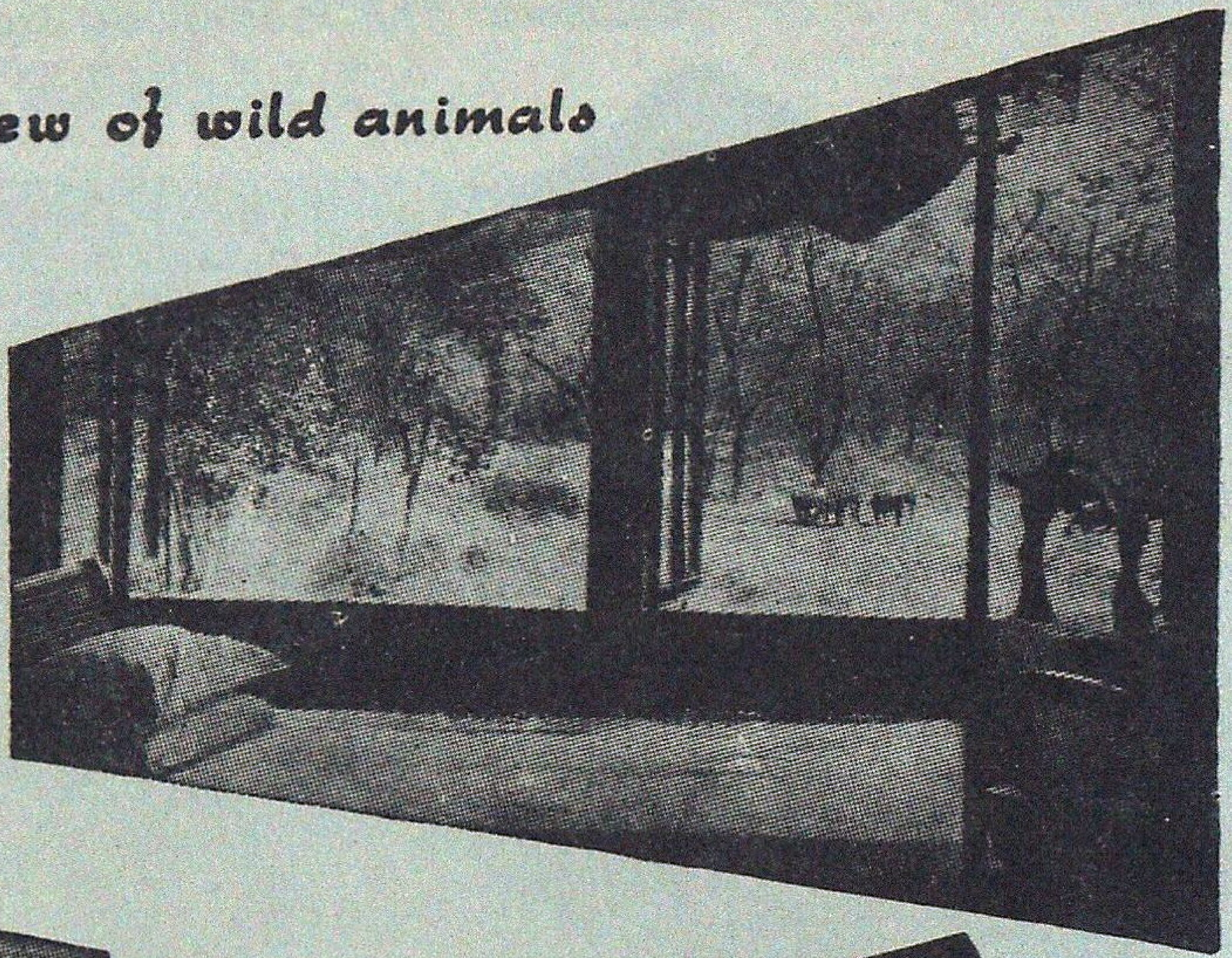

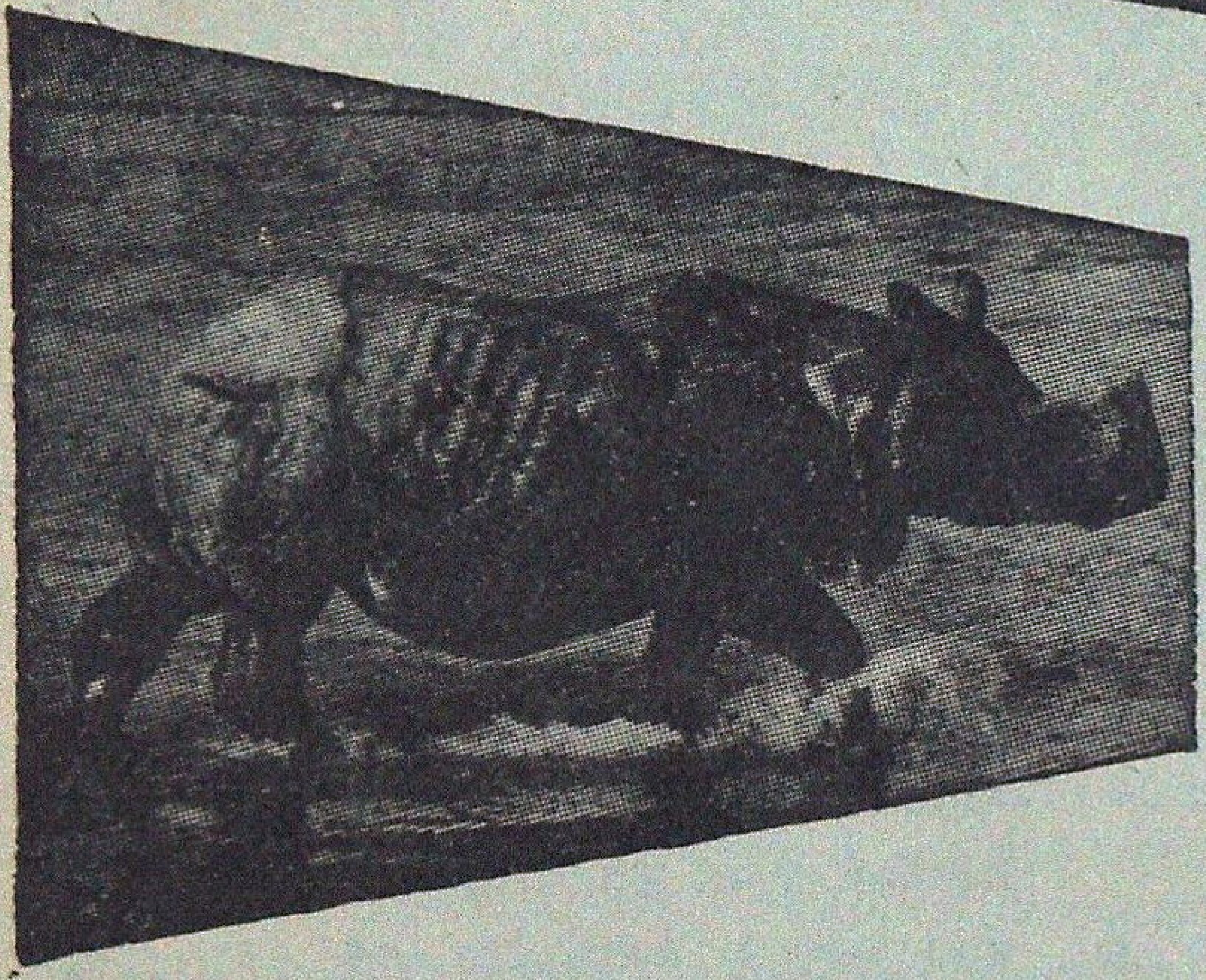

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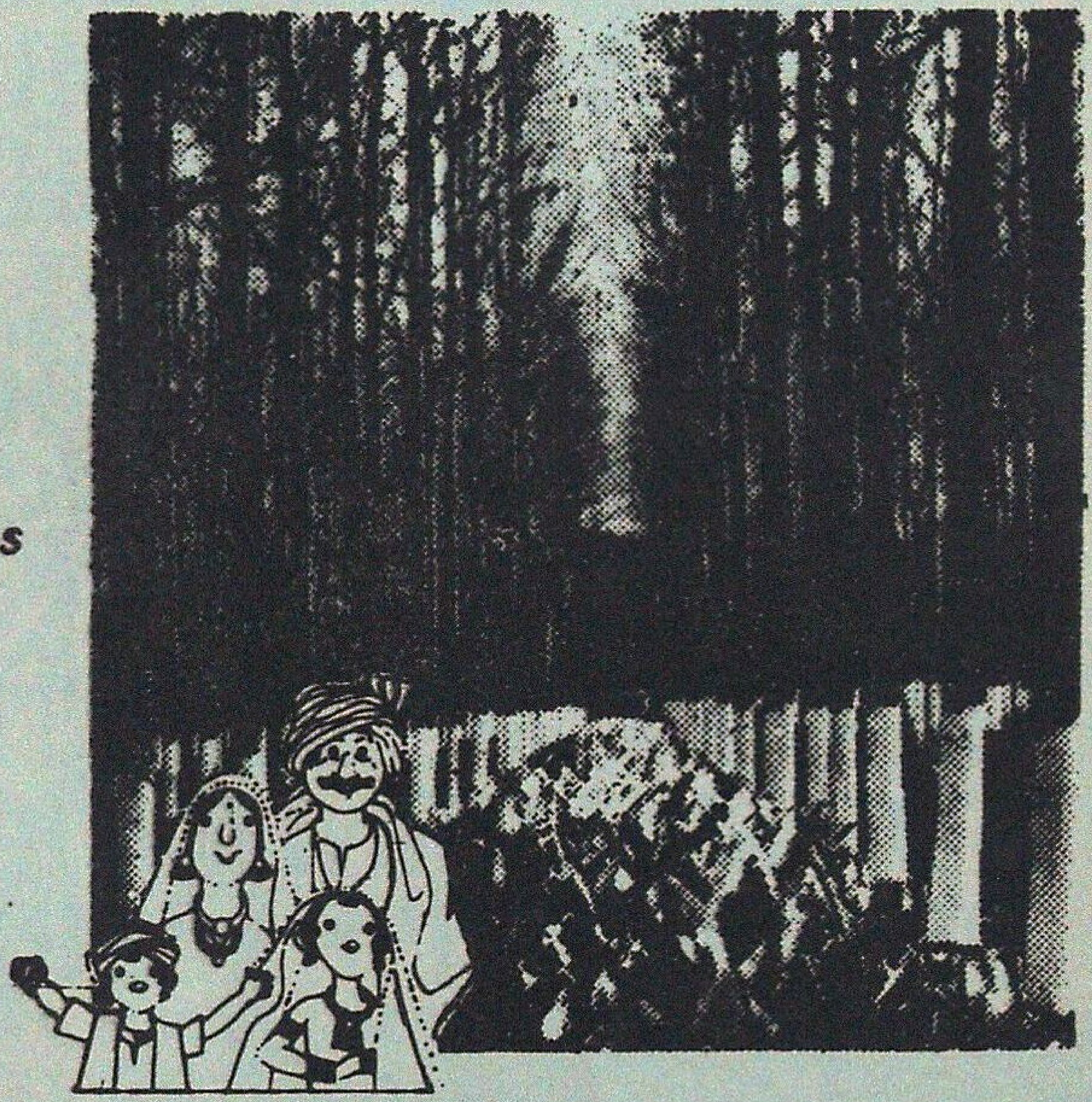

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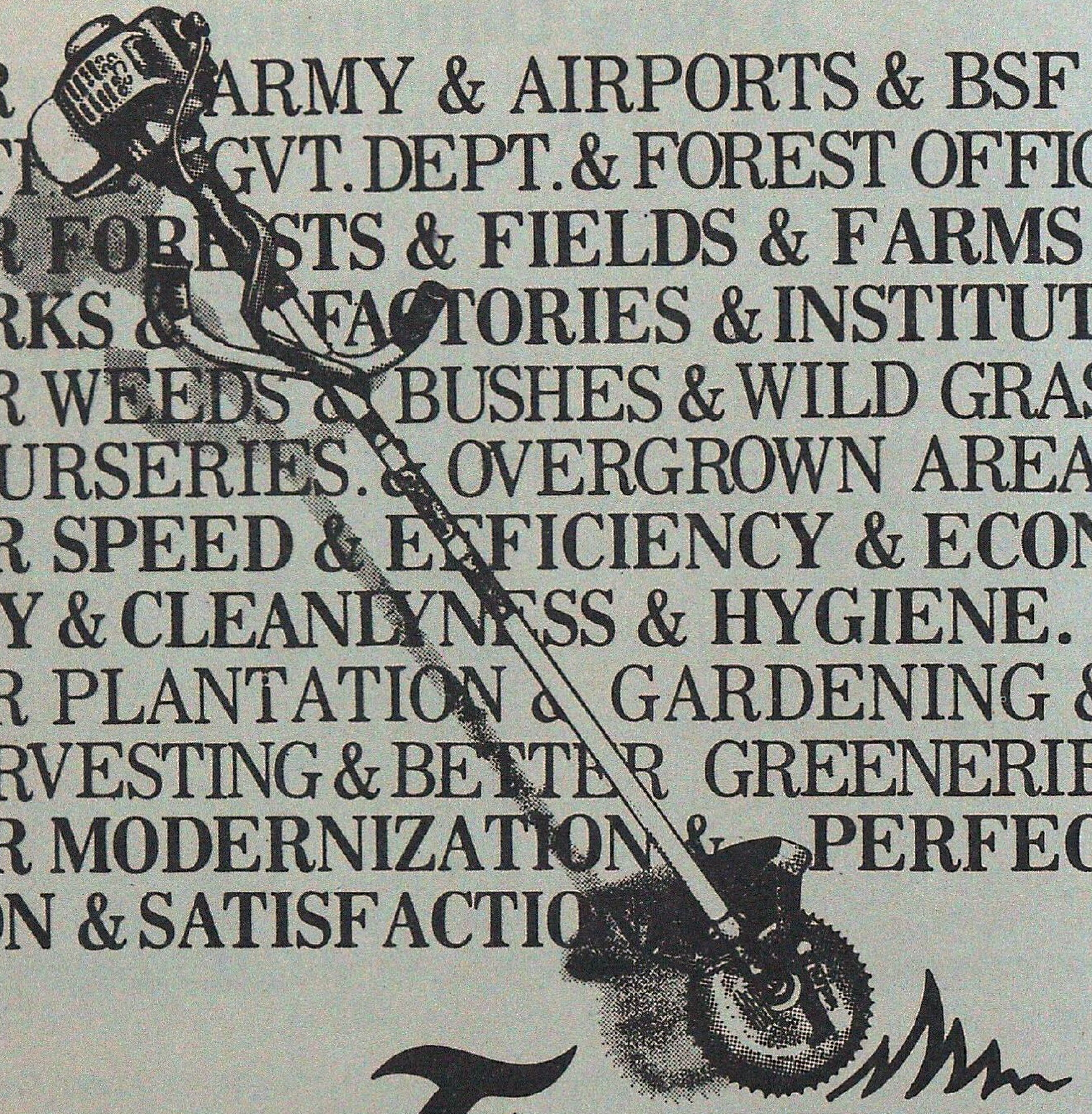

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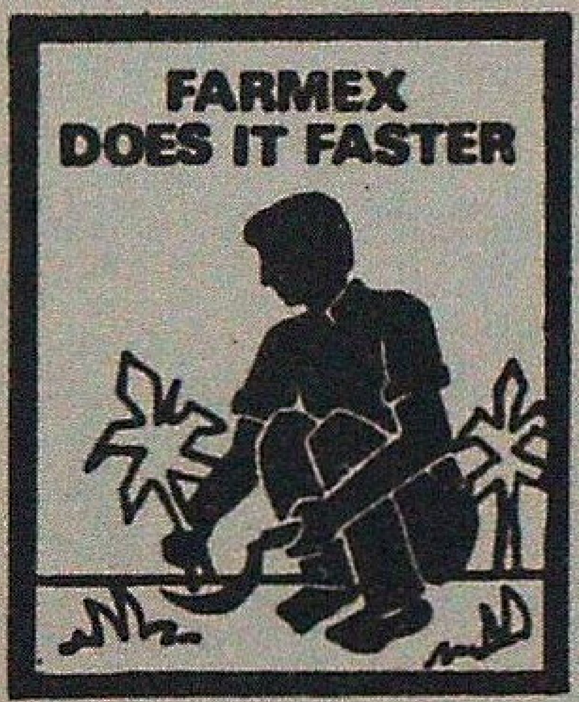

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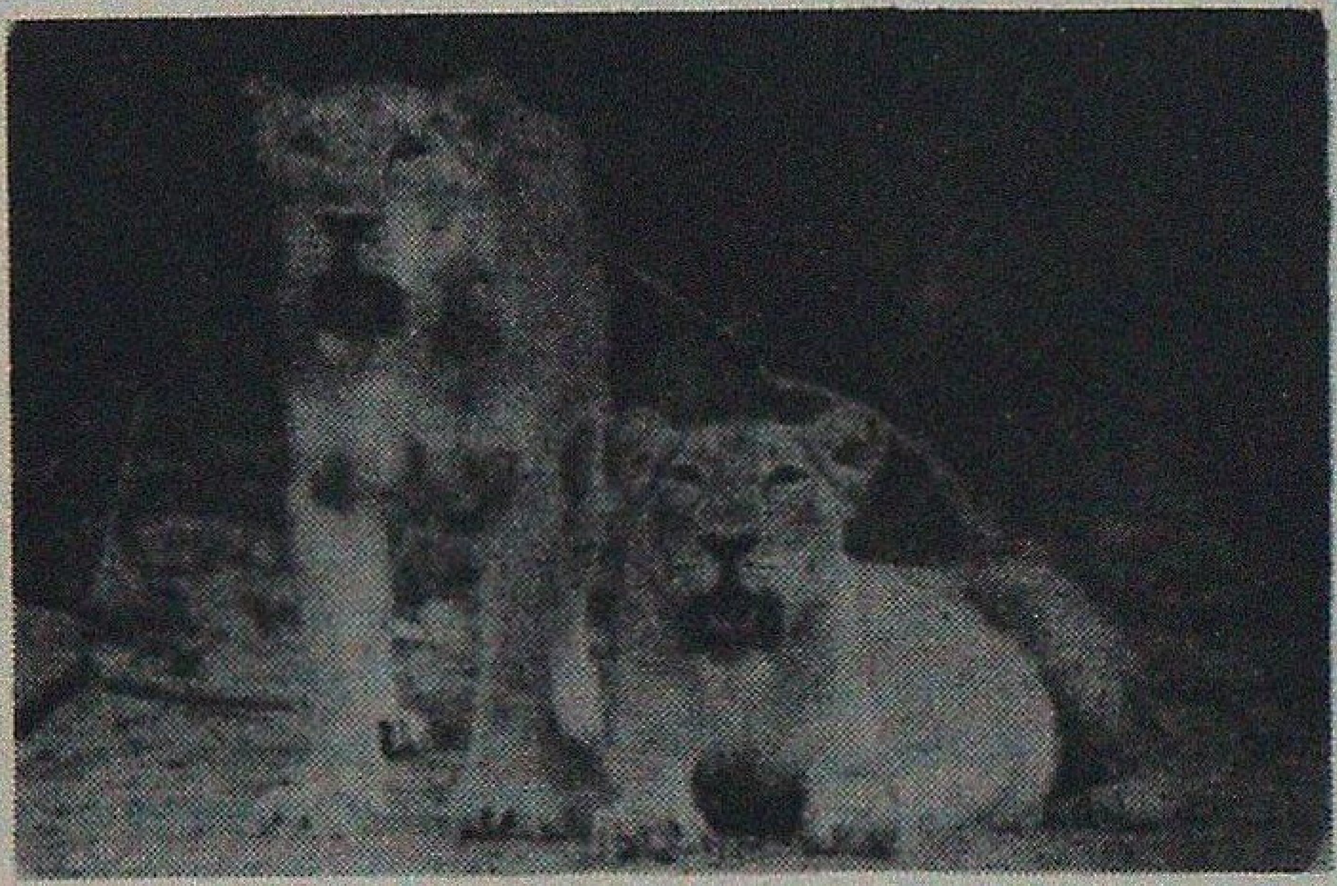

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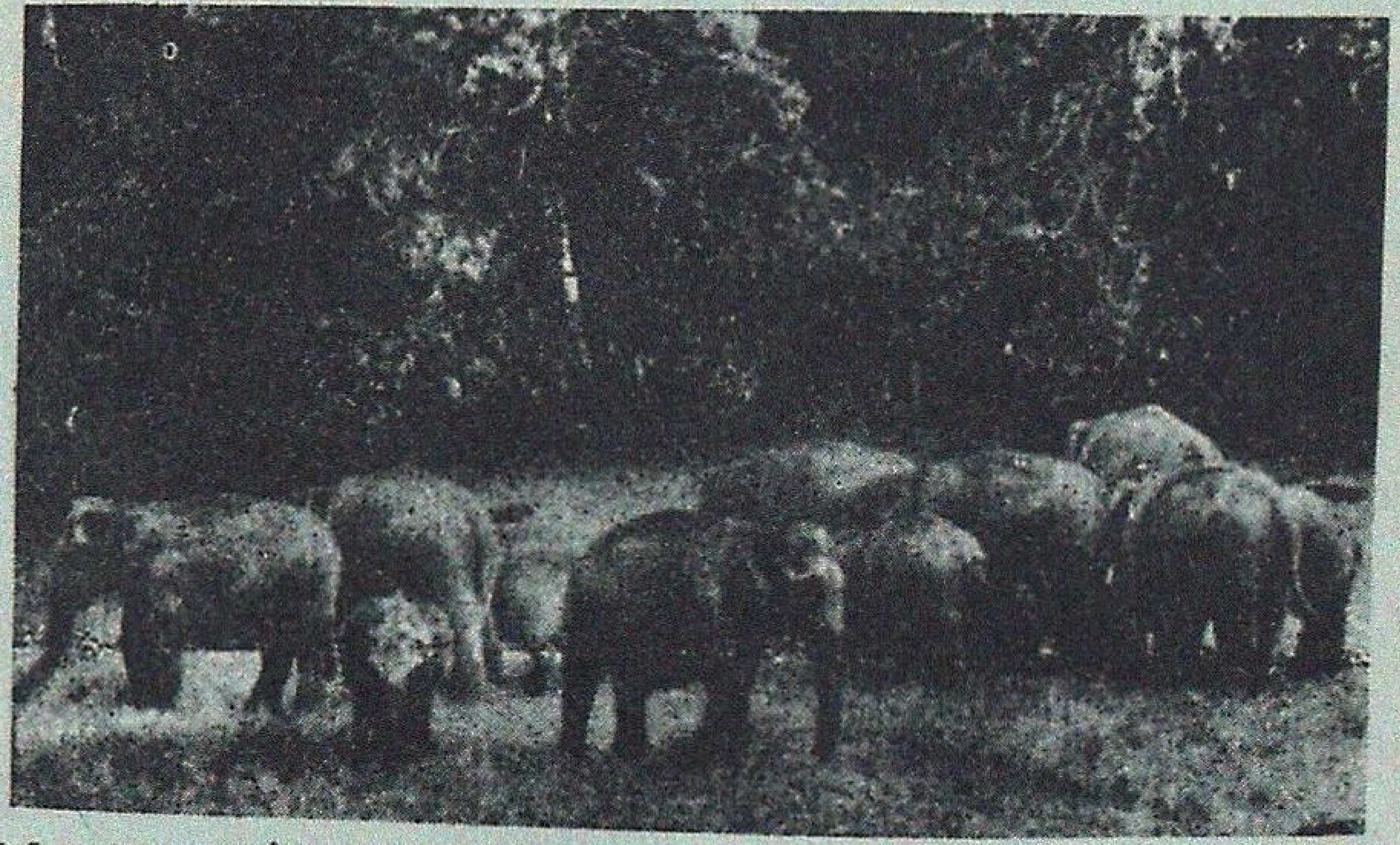

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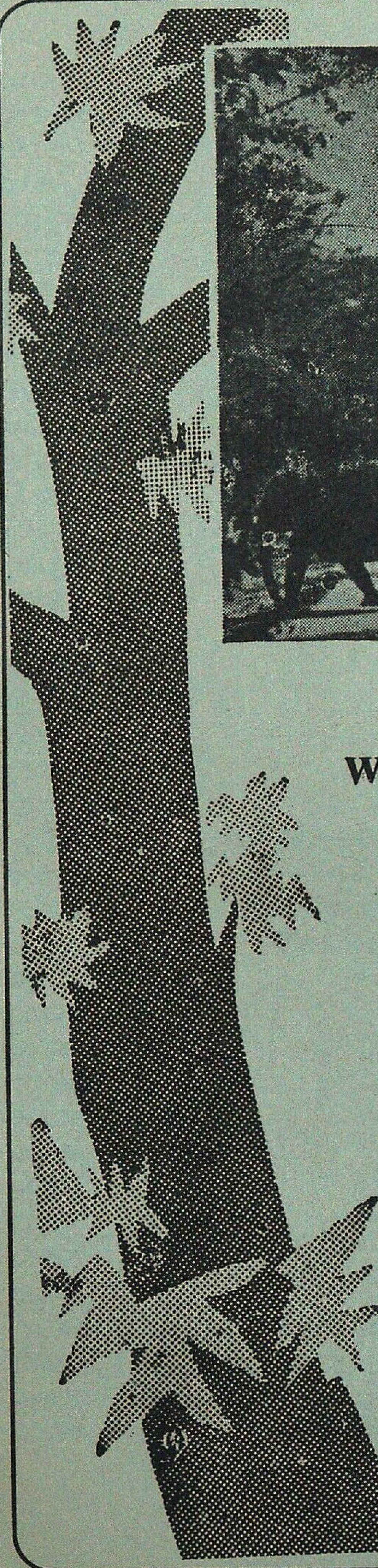

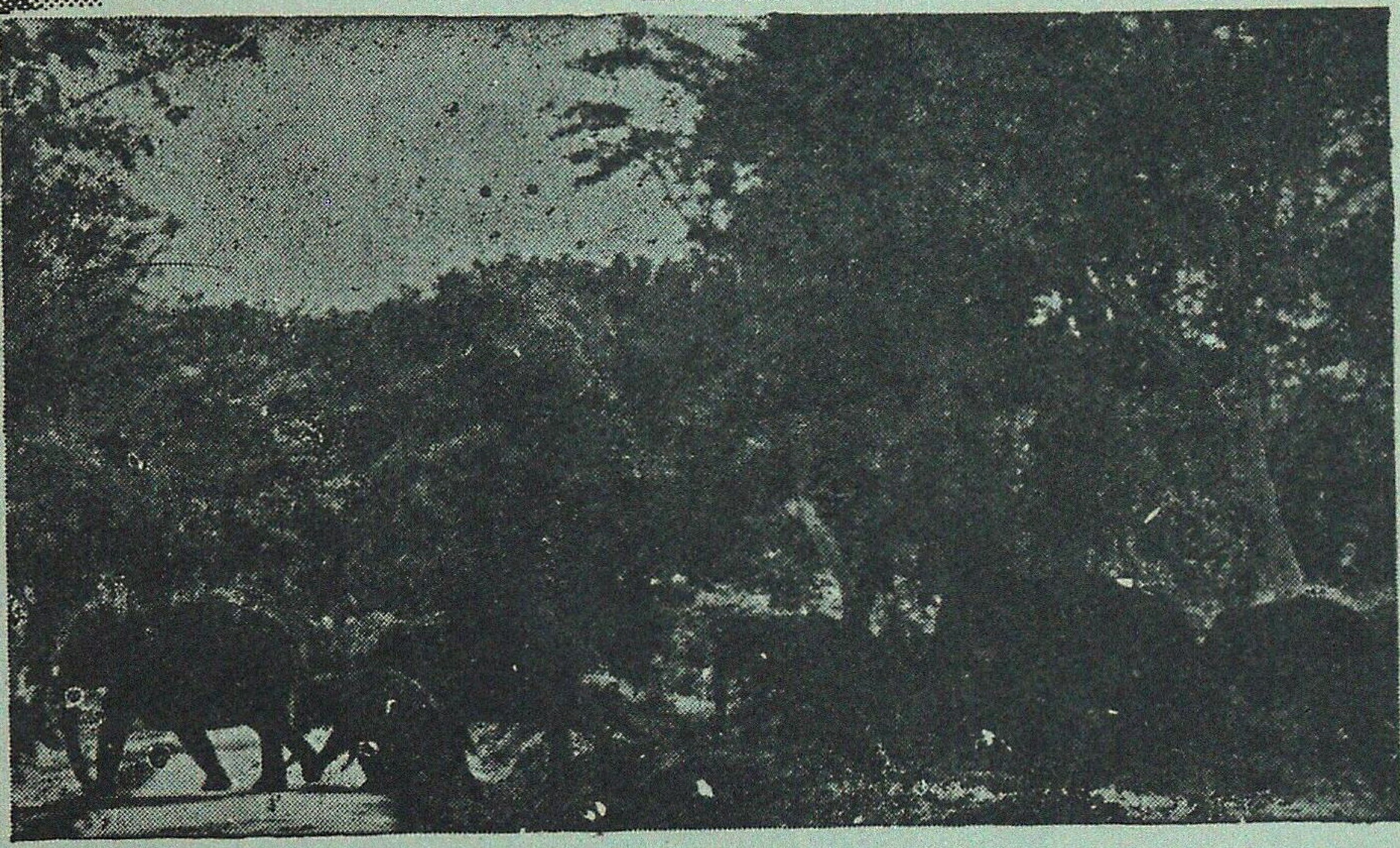

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